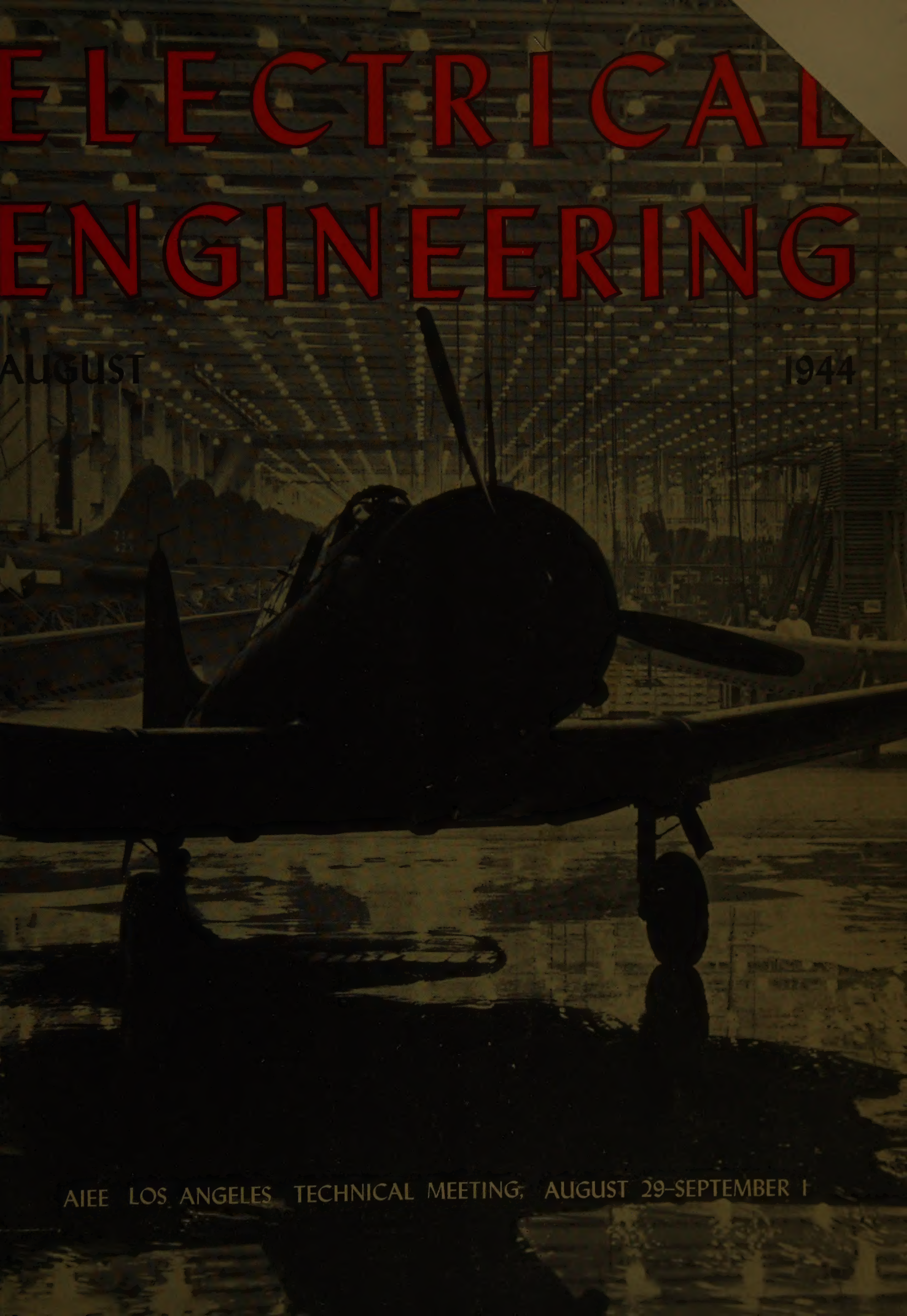
# ELECTRICAL ENGINEERING

AUGUST 1944



AIEE LOS ANGELES TECHNICAL MEETING, AUGUST 29–SEPTEMBER 1

# ELECTRICAL ENGINEERING

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1944

**The Cover:** A night view of the end of the Douglas *SBD* aircraft assembly line. More than 50 of the technical papers to be presented at the Los Angeles technical meeting, August 29–September 1, will deal with aircraft applications. Photo courtesy *Aeronautical Engineering Review*



## TRANSACTIONS SECTION

(*Follows EE page 322; a preprint of pages 549–612 of the 1944 volume*)



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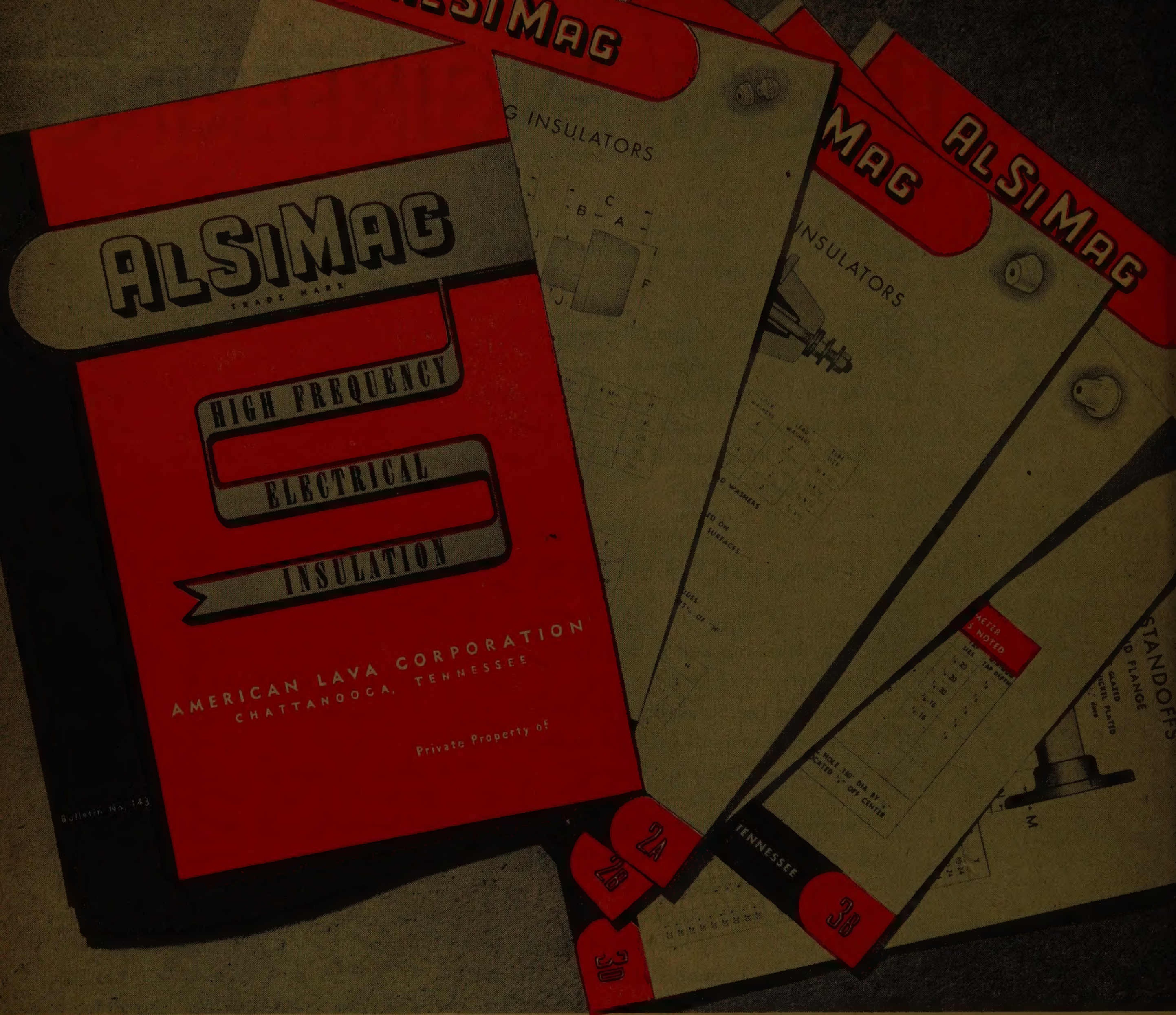
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# The Engineer's Present and Future Responsibilities

WILLIAM McCLELLAN
FELLOW AIEE

**Integration of all the separate postwar planning now being done by government, business, labor, and management is urged in this article. The status of the engineer as a professional man entails special responsibilities.**

EVERY professional man has hurdles to get over if he is to succeed. To start with, he must be a mechanic. The danger is that he will never be anything else. The medical man must be skilled in observations and diagnoses which can be purely mechanical. The surgeon must be an adept in dissection and tying knots. The lawyer must have a somewhat mechanical ability in stating definitely an idea, or meeting of minds, in words. Any honest so-called professional man strives to do the job at hand to the best of his ability. He wants to earn his pay. In this, however, he is no different from the honest toolmaker working to a thousandth of an inch. If their several abilities go no further, why should they be called professional men? What is the difference between the most highly trained mechanic and the professional man? I have no doubt many men would give many different answers. To me the answer is that the professional man never forgets human relations and the progress of human development. The true professional man sees more in his job at hand than a repair, a victory, or material achievement. Each such job at hand by which he earns his daily bread is part of a fundamental personal purpose to aid humanity in general. He means by his whole work and life to make the world better. He is willing also to give time and thought, for which he is not paid, in the hope of making human relations closer and more sympathetic. In short, he adds to his devotion to his client or customer a devotion to humanity.

The engineer in his race onward faces a special hurdle. I often illustrate this by a homely comparison. The young law graduate enters some law office as a cub. His first job may be to carry some papers to a client for signature. At the beginning his mind is set on a conflict between people, on a problem in human relations. The young engineering graduate gets a job at a drawing board or on construction. At this beginning he is studying materials and machines. These materials and machines are ultimately related to human needs, of course, but the engineer is not in contact with any particular humans involved. Therefore, there is a greater possibility that an engineer may confine his thinking and time to the materials and machines he may create or use. Unless he overcomes this particular hurdle, his professional status may suffer. Because engineers have not always been keenly aware of this hurdle and adopted special means to overcome it explains, perhaps, why they complain so frequently that the public does not give them as much professional status as the lawyer, doctor, and minister.

The never-to-be-forgotten fact is that each man and each woman is a citizen first. His or her responsibilities as a citizen always stand ahead of all others. Each chooses a vocation in order to earn a living, to be free, and to pursue his own happiness. But each of us has a talent, and the world as well as ourselves should benefit from the production of that talent. It is our present and future responsibility to make sure that the world gets its share.

Since Pearl Harbor, all our efforts have been centered on winning the war. Our production of old-type material as well as a tremendous volume of new types has far exceeded our original estimates. The engineer has had a tremendous share in this. Through his imagination and practical ability, new materials, new devices, new methods have astonished the world. It has been a magnificent achievement. Materially, the United States stands on a plane far above any other nation. There is just reason for pride. However, let us not forget the old saying, "Pride goeth before destruction and a haughty spirit before a fall." And also, in the language of the Book, "Let him that standeth take heed lest he fall."

Postwar days are coming and we can "fall." The United States then will face gigantic problems, and they will not solve themselves. We must plan the solutions, and yet we cannot afford to abate our efforts to win the war. What do we face? We face a world, much of which has been destroyed, and all of which will be imploring for help to rise out of poverty, hunger, and disease, and possible despair.

We shall face a United States with an enormous debt but with a productive capacity at least 60 per cent greater than we ever had in peacetime. We face a demand for a government of greatly expanded functions, the expense of which will overwhelm us unless government can operate efficiently without waste.

We face nations everywhere which will of necessity, because of economic destruction and dislocation, resort to state control and management of business. We have to wonder what the impact of this will be on us.

We face a demand from our own people that the individual be not submerged, that he be free to work out his business and social life as he wills within our enormously complex business and social structure. This is the "free enterprise" which we had in the early days of America. We want its return, as free individual enterprise.

In these circumstances it is indispensable that production be maintained at the highest possible level, that we use our huge productive capacity. Experts estimate that we should produce $140,000,000,000 worth. This is $40,000,000,000 more than we ever before produced in peacetime.

Such production, it is estimated, would help utilize 55,000,000 workers. This would mean no unemployment of employables.

Next—this huge production of goods and services must be placed in the hands of consumers. It must be sold. It must be sold at very low prices. All possible consumers must have enough money to buy what they can use.

Do not forget that this huge production, we have been talking about comes from

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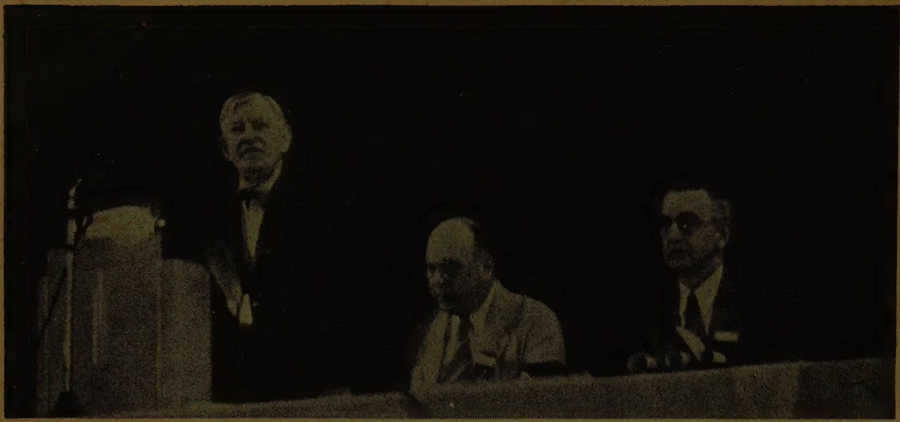
An address presented at the AIEE summer technical meeting, St. Louis, Mo., June 26–30, 1944.

William McClellan is chairman of the board, Union Electric Company of Missouri, St. Louis, Mo., and past president AIEE.



**Past President McClellan addressing the AIEE summer technical meeting. At the right are President Nevin E. Funk and National Secretary H. H. Henline**

all of us—managers, engineers, lawyers, doctors, sales workers, transporters, plant workers, farmers, miners, and others.

Low prices will come by top efficiency in every sector of production and distribution. Adequate purchasing power, a continuous supply of money to keep plants at top efficiency and to make sure that necessary new plants can be provided, will come if each producer gets his proper share in wages, salaries, interest, and dividends.

Yes, efficiency in every operation is the absolute necessity. Efficiency is by no means a new word to you as engineers. The best definition of engineering I have ever known is the efficient use of men and materials for the service of man.

Your job in peacetime will be far more difficult than what you did in war. In war there was one dominant motive. There was no question of expense. There was no uncertainty. There was no question of demand but only that of supply. No war producer could have any mistaken notion of getting along without you, or of not listening to you.

Our peacetime production will fail in its purpose, unless the same spirit prevails. That purpose is a very large one. It is not merely that everyone may have a job which will give him creature comforts and animal security. Men also have minds and souls. They need serenity and inspiration, as well as food and shelter. They need to live in the very broadest meaning of that word. They need to have everything there is to be had in life.

So, efficiency in production and distribution is only one of your responsibilities. Let us call it your vocational responsibility. I have no fear that you will not discharge this responsibility. You have proved it too often for there to be any doubt. But you have a responsibility far wider than any vocational responsibility. You have what I talked of as professional responsibility. In simpler terms you have a responsibility as a citizen.

The huge production and distribution of material goods and services must be accomplished within a governmental and social frame. There are those who think the frame must be a state-planned economy. It looks very much as if every other country in the world may be compelled to resort to a very great degree of governmental management of business, at least for some years. Opinion in the United States is against this. Nevertheless, we understand that, in our modern complex industrial world, governmental policing of business will have to be far more extensive than heretofore.

I tell you with all the force I have that, unless representatives of business, labor, farmers, professional men, and government sit down around a table and make this frame, all our vocational efforts will be blocked. Being blocked means utter confusion. History shows that when there is disunity and confusion the worst elements in society make progress.

All groups are planning, but there is no one national plan in the making for domestic life or for international relations.

What shape must this frame have which is to make possible merely our primary and basic postwar plans—$140,000,000,000 of production and distribution, and satisfactory jobs for 55,000,000 workers?

First, government must reorganize itself so as to perform efficiently and at least expense its enormously increased tasks of policing our economic activities and making possible social and economic security for all. This must be done so as to permit the greatest freedom for individual enterprise and to encourage the greatest effort of every individual in production.

Second, management and labor jointly must install a system of conference and action so that the greatest efficiency in production and distribution may be attained in order that goods and services may be had at the lowest possible prices. Neither can do this separately.

Third, a well-ordered scheme of taxation must be devised, so that all groups will pay their proper share and no group will be hampered in its efforts for the common good.

Fourth, wages, salaries, interest, dividends, must be allocated so that every man and woman shall be an adequate purchaser in order to have whatever his station entitles him to have for a satisfactory life, and so that he can do his share in providing risk capital for continuous economic progress. Too few people understand how important is the way a country is taxed to raise a large sum like $20,000,000,000. The method can spell success or failure.

Fifth, a system of money, credit, and tariffs must be arranged which will give permanent stability to our whole economic process, both domestic and international.

No matter what other planning we do, it will all arrive nowhere unless money, credit, and taxation plans are right and stable.

We could go into a hundred details that are being talked about quite vociferously just now. But, important as they are, they are details and not so important as the frame within which we must live and operate.

Getting this frame, so necessary to success, is not part of anybody's vocational responsibility. Vocational responsibility is a personal matter. It can be discharged within the walls of an individual office or plant. Getting the frame is a joint responsibility of all of us, thinking and working together.

The sad fact at present is that there is no such joint planning. Farmers, labor, business, professional men, and government are all planning—but separately. Suppose the Army, Navy, Merchant Marine, and the home front had all planned separately to win the war. Suppose there had been no general staff. In war the government, of necessity, makes the general plan and all of us fit our vocational plans into the general one.

We say we do not want peace planned that way. We say we want to resume democracy in peacetime. Do we mean it?

We think democracy is the best form of government but we had better understand that democracy is the most difficult form of government to operate.

We can have government of, by, and for the people, but only if the people plan together—not in separate groups.

Engineers, like lawyers and medical men, have very special responsibilities. They are educated men. They are trained men. They have special abilities. Please God, they will not stop at mere material effort. Please God, they realize that all their efforts and their training, all their intelligence, and all their devotion must be directed toward human welfare.

We pride ourselves on our material progress. We call it civilization. What matter if we talk across oceans, fly over mountains, travel at high speeds, see in New York some occurrence in London, if we are as ready to spring at each others throats as we were when we had none of these things. The Book says—"What shall a man profit if he gain the whole world and lose his own soul?"

# Carrier Telegraph Systems

F. B. BRAMHALL
MEMBER AIEE

**Since the invention of the telegraph a century ago, refinements have been made until as many as 144 automatic printers operate at 60 words per minute over a pair of wires. Some of the steps in this evolution are reviewed in this article.**

IN THE TIME of Samuel F. B. Morse, inventor of the telegraph, a single telegraph transmission of perhaps five words per minute represented the maximum use that could be made of a telegraph wire. Today over 97 per cent of all telegraph communication in the United States is carried on by automatic printers, which are known as teleprinters or teletypewriters. The word-per-minute speed of such machines is 60, and as many as 144 of these machines are now worked over a two-wire pair. The relative wire economies of the modern system and that in use even relatively recently, when the telegraph sounder still clicked away its 20 words per minute, are obvious.

How these things are accomplished may be explained basically in simple language and diagrams. First, combinations of two things taken five at a time are sufficient to identify all the letters in the alphabet. Figure 1 shows the electrical circuits of a printer in which five letter-selecting magnets are operated by five conductors. Figure 2 shows the same result accomplished by operating the five selector magnets consecutively one after the other with only one wire but with the addition of a sending and receiving commutator. An analogy of this form of circuit, known as the multiplex, is shown in Figure 3 in the form of a belt conveyor carrying alphabet cards from three transmitting positions on the right to three receiving positions on the left. The sending dealer picks one card from each row, working from top to bottom, placing them on the belt. The receiving dealer distributes the cards as they arrive in a similar manner and in proper sequence. The rows correspond to printers, or channels, and on trunk circuits two, three, or four of these channels are operated on a single wire. This type of system has the disadvantage of wasting line time if, for example, one of the channels is idle. The varioplex or expanding-channel principal of operation overcomes this difficulty by skipping an idle channel and allowing the remaining working channels to operate at a more rapid rate. Using again the belt-conveyor analogy, Figure 4 shows a three-channel circuit with two channels operating and with the third in the act of entering. The small numbers under the belt represent the moment at which the channels can be entered and have no relation to the channel identity of the cards that happen to be above them. The sending dealer enters channel 3 by placing a card marked "IN" on the first space designated by "3" that the belt brings up. The arrival of such a card at the receiving station in such a position is the cue to include that channel in future distributions. This type system is used largely in customer-to-customer service where direct connections are necessary but the total business does not warrant a full-time channel. The line transmission problems met with either system are identical, and the carrier-current systems which will be described were designed primarily for four-channel multiplex working with the frequency of the signaling impulses at 66 cycles per second.

At this point a detail of terminology should be clarified. The word channel has, unfortunately, two distinct meanings, not alone in this article but in all telegraph-transmission literature. The printer-to-printer communication circuit on a multiplex system is called a channel. Then when a means was devised for sending the signals representing the intelligence of a four-channel multiplex over the wire with those of several other multiplexes such paths also were called "channels." Alexander Graham Bell was experimenting with telegraphy when he hit upon the idea of dividing the frequency spectrum into small pieces and telegraphing independently over each such piece, the currents being carried over a common transmission medium. The telephone incidentally was only a by-product of Bell's effort to provide multiple transmission paths for Morse's telegraph. Today the voice-frequency spectrum is divided with channel tuners, or filters. Ten voice-frequency channels separated by discrimination adequate to prevent interchannel interference are obtained between 350 and 3,250 cycles. These are called voice-frequency channels only because the frequencies employed fall within the range used by the voice. The centers of the pass bands of these tuners are located at 300-cycle intervals from 450 cycles to

Essential substance of a paper presented at a meeting of the AIEE Philadelphia Section, April 10, 1944, commemorating the first commercial telegraph service.

**F. B. Bramhall** is transmission research engineer, Western Union Telegraph Company, New York, N. Y.

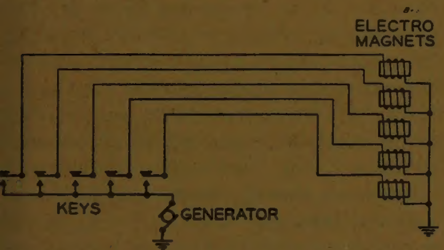



**Figure 1. Five-wire printer**

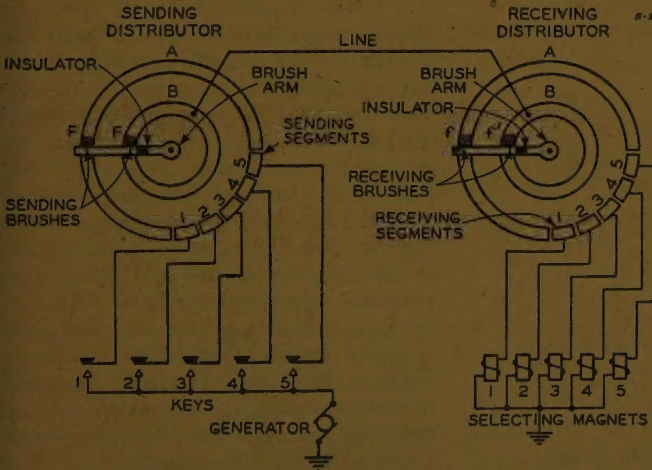



**Figure 2 (left). One-wire printer**


**Figure 3. Belt-conveyor analogy of multiplex**

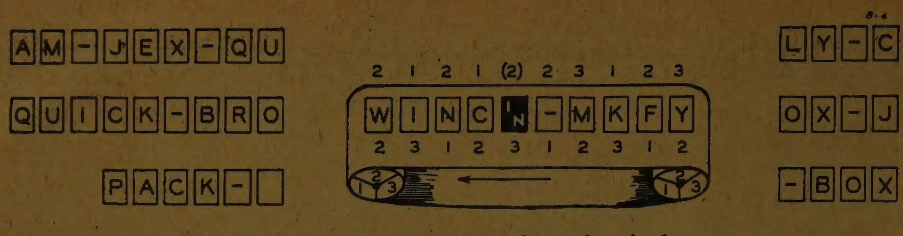



Figure 4. Belt-conveyor analogy of varioplex

3,150 cycles. The effective width of each band from input of sending tuner to output of receiving tuner is 160 cycles.

Until five years ago, signaling in these channels was accomplished by amplitude modulation, as illustrated in Figure 5. A source of carrier, a relay actuated by the multiplex signals, and a sending tuner comprise the essential sending-end equipment. The output sides of the sending tuners are multiplied together and the currents in the line are then seemingly a jumbled mess quite incapable of telling anyone anything. The situation is not actually so hopeless, however, since each receiving tuner (all of them multiplied together at their input ends) picks out its own frequency to the exclusion of all others. The device labeled demodulator is a rectifier which delivers a signal shown as *C* to the receiving relay. Transmission in the opposite direction must be done either on the same or another pair with an exact but inverted replica of this fundamental apparatus. So much for amplitude modulation, in some quarters now considered to be obsolete and disappearing from use. But before passing it should be noted that side bands of the nominal carrier frequency must be transmitted, first-order side bands spaced above and below the carrier an amount equal to the modulation (telegraph signaling) frequency. As a matter of fact, a little more band width than this requirement would seem to dictate is necessary in order to send, without distortion, pulses of varying length. A band width equal to two times the signal frequency plus 15 per cent gives substantially perfect results.

Frequency modulation, shown schematically by Figure 6, is the preferred method of operation today. The source of carrier frequency is an oscillator capable of having its frequency altered under the control of the telegraph signal sending relay. Practically for signaling at 70 cycles per second, the speed for which this system was designed, the oscillator frequency moves down 70 cycles to represent a marking impulse and moves up 70 cycles to represent a spacing impulse. It moves up and down gracefully, not abruptly, performing the transit in approximately the length of time measured by the duration of a signal pulse. Obviously the oscillator frequency then only passes through the nominal channel frequency, never halting there. However,

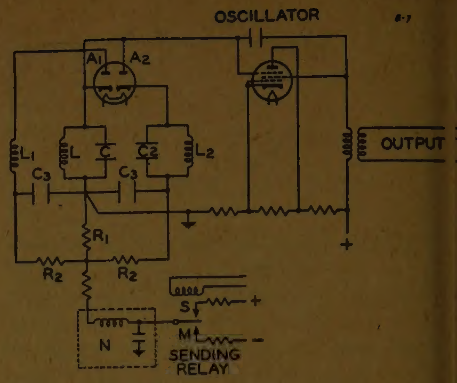



Figure 7. Schematic diagram of frequency-modulation transmitter

analysis of the resulting wave when continuous a-c signals are transmitted shows half the energy to be at the carrier frequency and just less than one quarter at either side frequency. This kind of frequency modulation is said to have a deviation ratio of one and is known to have side-band energy relations approximating very closely those of amplitude modulation. It is no more wasteful of spectrum space than amplitude modulation. The sending tuner on a frequency-modulation channel performs essentially the same function as on an amplitude-modulation channel, that of eliminating unwanted (higher order) side bands and other spurious frequencies which otherwise would let the channel interfere with the operation of its neighbors. The receiving tuner (and both tuners are the same tuners as used for amplitude modulation) picks out the frequencies intended for its detector as before. The detector in this instance is a push-pull arrangement of two linear frequency-discriminating networks so arranged that a frequency 70 cycles below nominal causes a direct current to flow in one rectifier tube and a frequency 70 cycles above the nominal value causes an equal current to flow in its mate. The currents of the two discriminators are separately amplified and fed, still push-pull fashion, to equal and oppositely poled windings of a receiving relay.

A comparison to the amplitude-modulation method is that of a polar system as against a single-current system. Frequency modulation provides the advantages pertaining to polar signaling, greater freedom from the effects of extraneous disturbing currents and greater freedom from the particularly distressing effect of level changes in the incoming signal. As a matter of fact, since the intelligence is now carried in the frequency change and not in the amplitude change, the channel receiving amplifier may be so designed as to ignore completely all amplitude change. In the words of the electronics engineer, the limiter stage has a range of 50 decibels. Figures 7 and 8 show the details of the frequency-modulation oscillator and the discriminator detector.

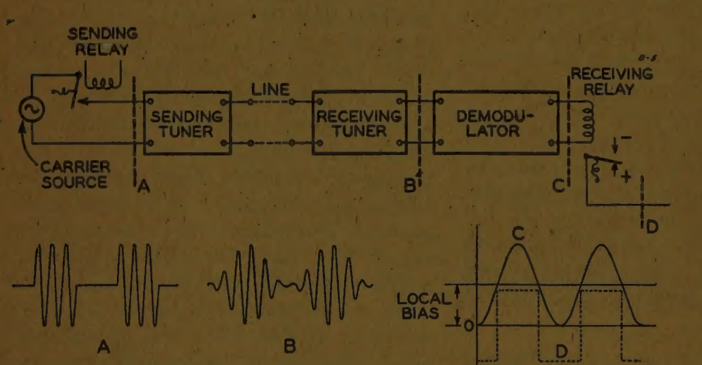



**Figure 5 (left). Fundamental amplitude-modulated carrier telegraph circuit**

*A—Keyed carrier*
*B—Received carrier*
*C—Relay current*
*D—Relay operation*

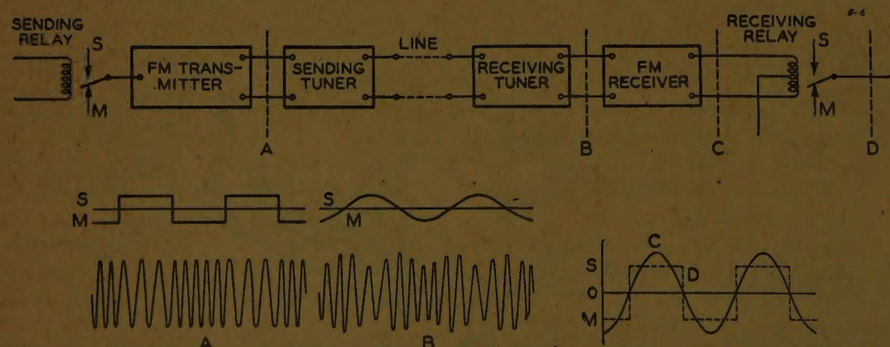



Figure 6. Fundamental frequency-modulated carrier telegraph circuit

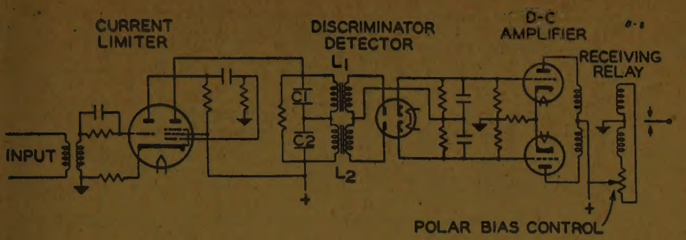



**Figure 8 (left). Schematic diagram of frequency-modulation receiver**

Figure 9 shows the remarkable ability of the frequency-modulation channel to resist the disturbing effect of crosstalk noise. The same or greater imperviousness to impulse and fluctuation noise also can be shown.

Figure 10 shows four channels of frequency-modulation terminal sets including a great amount of monitoring and switching apparatus, a substantial part of which is a duplex grounded circuit repeater for extending the telegraph circuit to a point beyond the carrier terminal.

There is also a need for narrow carrier bands for single teleprinter operation. To meet this, a closer-spaced channel layout is employed. The channels are spaced 150 cycles apart and the effective band width is 80 cycles. Frequency modulation in these channels employs a deviation of 35 cycles above and below the mid-channel frequency. The operating characteristics of such channels are quite analogous to those of wide-band channels and the equipment is identical in appearance. For simplicity the discussion will be continued on the basis of the wide-band channels, noting here only that wherever traffic needs demand narrow-band channels they are substituted for the wide on the two-to-one exchange basis indicated by the 150- and 300-cycle spacing relationship.

Some voice-frequency four-wire circuits are operated in the eastern part of the United States. On these, ten channels of like frequencies are sent eastward on one pair and ten westward on another. Other four-wire circuits carry two groups of ten channels with frequencies up to 6,750 cycles eastward on one pair and westward on another. The low-capacity two-wire type *E* system carries a group of channels westward in its natural voice-frequency state and a similar group eastward with the bottom and top channels located at 4,050 and 6,750 cycles. Figure 11 shows the essential elements of *E*-system equipment. The transmission line at either end is terminated in the directional separation tuners. The westbound path, in addition to strategically located amplifiers, has tuners which pass only those frequencies headed west. The eastbound path is likewise walled in by tuners at either terminal which pass only the eastbound frequencies. A process of translating is used to pick up a block of voice-frequency channels from 450 to 3,150 cycles and drop them in the space from 4,050 to 6,750. At the west terminal, a particular channel, for example, the 450 cycle, is appropriately mixed with some 7,200 cycles called the translating carrier. One result is the sum (7,200 + 450) 7,650 cycles, which falls outside the path beyond the upper wall of the directional tuner. Another result is the difference (7,200 − 450) 6,750 cycles which goes through the tuner and to the east channel terminal. It may be seen that in the new location the channel is still frequency modulated, that the swing is still 70 cycles above and 70 cycles below the nominal channel frequency exactly as it was, and that the side-band relations are the same. The same thing may be done with channels 2, 3, 4, and so on up to channel 10 at 3,150 cycles, the latter coming out at 4,050 and moving 70 cycles up and down in conformity to the multiplex signals. In many systems this translation is accomplished this way with a private mixer or modulator for each channel. In those to be installed henceforth one single modulator will translate them all in one operation accomplishing exactly the same result. At the receiving terminal the signals are mixed with 7,200 cycles and come out again between 450 and 3,150 cycles where the channelizing tuners separate them as already depicted. True, a by-product is some sum frequencies between 11,250 and 13,950 cycles, but these are ignored by the channel tuners.

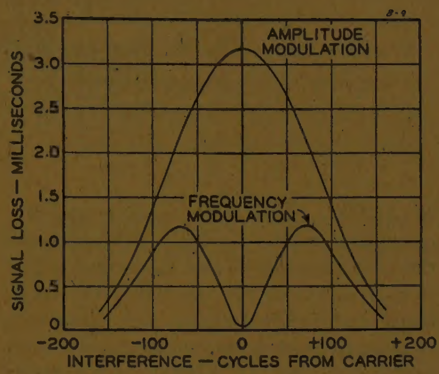



**Figure 9. Effect of single-frequency crosstalk on amplitude- and frequency-modulated systems**

*Crosstalk interference in 60-cycle modulation*

$$\frac{\textit{Peak carrier}}{\textit{Peak interference}} = \textit{12 decibels}$$

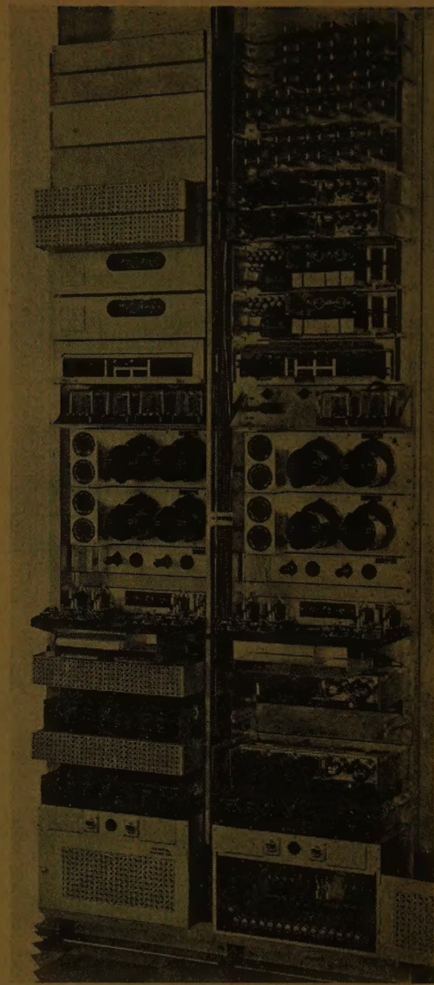


**Figure 10. Standard channel terminals**

Long type-*E* systems carry only eight or nine channels because of the proclivity of pass bands to become narrower and narrower as more and more tuners are placed in the path. Figure 12 shows that

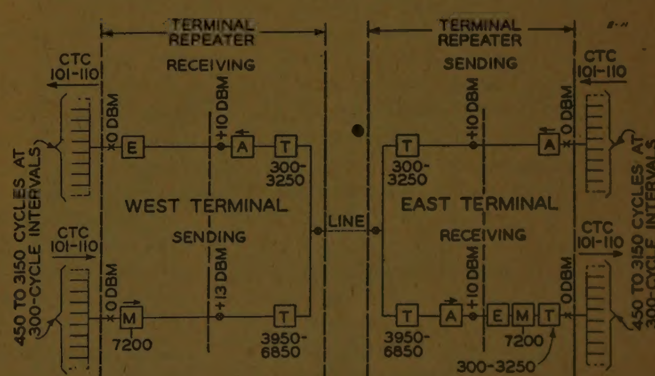



**Figure 11. Block diagram of type-E system**

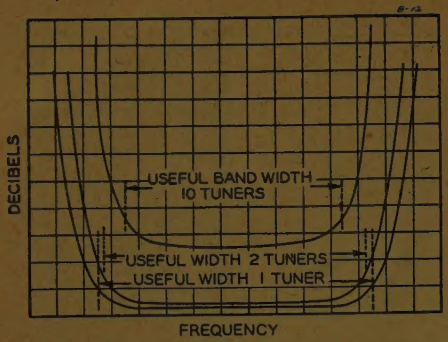



**Figure 12. Effect of adding tuners in tandem**

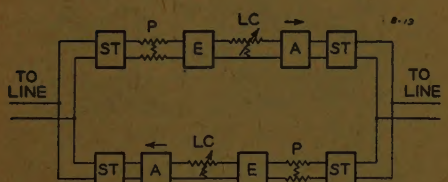


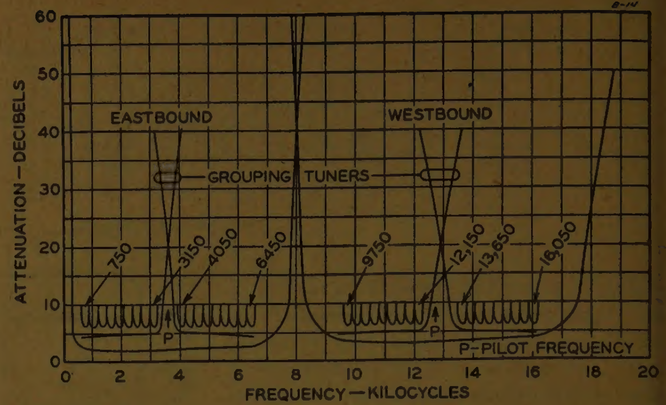

**Figure 13. Block diagram of two-wire repeater**

*A—Amplifier*
*E—Equalizer*
*LC—Level control*
*P—Building-out pad*
*ST—Separation tuner*

this unfortunate phenomenon is a matter of simple addition. The reason for more and more tuners in tandem in the transmission path is shown by Figure 13. Repeating amplifiers located at 200-mile intervals in long circuits must be employed to rebuild the signal strength. The eastbound amplifier must be constrained to amplify only those frequencies destined for the East hence it must be preceded by a separation tuner just like that used in the receiving side at the east terminal. It must also be followed by a tuner of like pass-range characteristics. The same reasoning applies to the westbound path. The result is two tuners in each path at each repeater station with attendant progressive narrowing of the pass band as the circuit length is increased.

The type-*F* system, in much more common use, provides two blocks of channels in either direction. The spectrum layout and the essential characteristics of the tuners required are shown by Figure 14. On *F* systems channel 1 is not used. Adequate separation between eastbound and westbound frequencies is allowed, however, so that circuits 2,000 miles in length may be worked without further loss of channels due to tuner constriction. Figure 15 shows the basic elements and method of translation employed in this system. Eastbound, the second block of channels is obtained by translation in every way analogous to that employed eastbound in the *E* system. Both westbound blocks must be relocated. This is done with but one translating frequency located midway between the two bands at 12,900 cycles. The difference frequencies are used for the lower band and the sum frequencies are discarded. The sum frequencies are used for the upper band and the differences are discarded. A pilot frequency located at 3,600 cycles eastbound and at 12,600 cycles westbound serves the dual purpose of controlling an automatic gain regulator at certain repeater stations and permitting the terminal attendants to communicate with each other on dispatching and like matters.

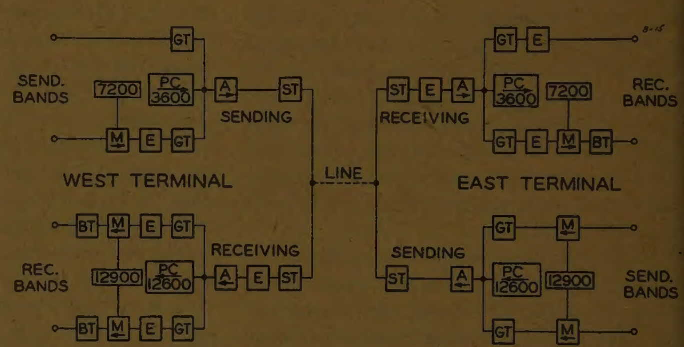
**Figure 14. Channel allocation of type-F system**




Another type of system called the *G* system accommodates four blocks of channels in either direction. Perhaps the present description of this system need go no farther than the statement that a novel and more efficient tandem arrangement of translators is employed. The problems of controlling unwanted products of modulation in equipment common to all channels were difficult in proportion to the system capacity but these have been successfully solved.

**Figure 15. Block diagram of type-F system**

*GT—Grouping tuner*
*ST—Separation tuner*
*BT—Band tuner*
*M—Modulator*
*A—Amplifier*
*E—Equalizer*
*PC—Pilot-channel terminal*




So far the principal concern seems to have been one of carrier-system design and little has been mentioned about transmission. The directions of transmission on the various systems are so chosen as to co-ordinate with each other and with systems used by the telephone company and the Western Electric equipment installed by the various railroad and pipe-line companies which have their own private communication systems. Figure 16 shows the directions of transmission employed with systems in common use by such corporations. Open-wire transposition patterns used with the various systems are beyond the scope of this article. There is a tendency at present toward the matching of open-wire and cable junctions rather than loading the cables.

Under the impetus of present national-defense activity but subject also to the material restrictions imposed by war, carrier use in Western Union is expanding. Economies are thereby effected, but further than this, transmission efficiencies are so much improved as nearly to revolutionize certain former practices. Whereas on physical circuits from coast to coast several regenerative repeaters were required, on carrier circuits none are needed. Many multiplex circuits have been greatly increased in speed and when the country can be covered with a more complete network further gains in this direction can be realized.

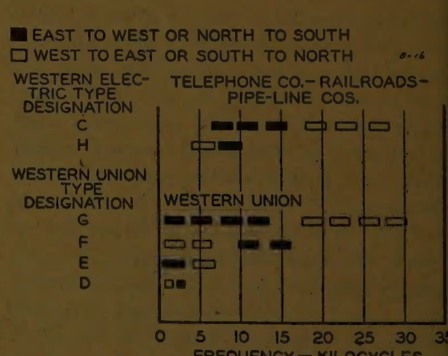



**Figure 16. Frequency allocation of two-wire carrier systems**

# Mobile Power Plants for War-Torn Areas

**Plants generating electric power are selected victims of war's destruction, and their replacement is vital to any rehabilitation program. Restoration is hastened by electric-generating facilities which may be moved on railroad tracks and placed in operation within a short time.**

POWER PLANTS are one of the targets whose destruction is certain in any area over which battles are fought. Power, however, is the prime necessity in restoring devastated areas as soon as they cease to be battlegrounds. To make initial power available at the earliest possible moment, mobile electric-generating plants in the form of railroad trains which may be moved to selected sites and quickly placed in operation are under construction by several manufacturers in the United States. The first units have already been delivered.

### A 3,000-KW POWER PLANT

One type of such a plant has been built by the General Electric Company and the American Car and Foundry Company. Providing 3,000 kw of electric power, it is embodied in a train of ten cars, consisting of locomotive-boiler cars, tenders, a turbine and condenser car, switchgear car, cooling-tower cars, and a car providing maintenance facilities and quarters for the crew. A view of the train is shown in Figure 1.

The fire-tube locomotive-type boilers operate at a pressure of 300 pounds per square inch and a temperature of 600 degrees Fahrenheit, and burn low grades of coal, fed automatically from the tender. The turbine car contains a 3,000-kw generator which delivers power at either 6,300 or 11,000 volts. The switchgear car contains the main switchgear, which is of the metal-clad type, together with indicating and control apparatus for the main generator. Two feeder circuits are brought out through each side of the car for connection to outside power lines.

Three cooling-tower cars contain wood cooling surface arranged in two cells. The wooden structure is mounted on a steel water basin on the car platform. Cooling air is supplied by four fans located in the top of the car and driven by direct-connected vertical motors, while water is circulated by a pump on each car. For operation where water is limited, the three cooling-tower cars are replaced by two radiator cars which require no water.

### POWER PLANTS FOR 1,000 KW AND 5,000 KW

Portable generating plants to which the name "power train" has been applied are being built by the Westinghouse Electric and Manufacturing Company in two sizes—1,000 kw and 5,000 kw.

The 1,000-kw unit consists of one boiler car, one turbine-generator car, one cooling-tower car, and coal-handling equipment. A two-drum water-tube boiler is used, designed for steam at 420 pounds per square inch and 730 degrees Fahrenheit. The turbine-generator car contains the condenser and switchgear as well as the 1,000 kw three-phase 6,300-volt 50-cycle generator.

The 5,000-kw "power train," shown in Figure 2, is made up of eight cars, arranged as follows:

1 and 2. Main steam condenser.

3. Main turbine-generator unit and switchboard.

4. Air compressors and boiler-feed-water pump.

5. Boiler-feed-water supply of 10,000 gallons.

6 and 7. Main steam-generating equipment.

8. Work shop and quarters for the crew.

Coal- and ash-handling equipment also is supplied.

Air is used as the cooling medium in the main steam condensers, which are designed for operation at outdoor temperatures from −40 to 95 degrees Fahrenheit. Eight condensing sections are installed on each of the two cars, with four blowers on each car.

Power at 6,300 and 10,900 volts is supplied by the 50-cycle 3,000-rpm 0.8-power-factor 6,250-kva generator. The same car

**Figure 1 (above). A ten-car mobile electric power plant for supplying 3,000 kw**

*A similar train is under test on an adjacent track in the background*

**Figure 2. Six cars under construction for an eight-car "power train" for supplying 5,000 kw**

that carries the generator also contains a 75-kw Diesel-engine-driven 380/220-volt 50-cycle generator for use in starting and totally enclosed metal-clad switchgear, with circuit breakers of 150,000-kva interrupting capacity.

The two boiler-car units are essentially duplicates and are arranged so that the stoker ends are adjacent to each other. Each contains a two-drum bent-tube water-wall boiler designed to supply 40,000 pounds of steam per hour at a pressure of 660 pounds per square inch and a temperature of 750 degrees Fahrenheit, together with superheaters, economizers, induced- and forced-draft fans, and measuring instruments and control equipment. Compressed air is used to operate the boiler stokers, coal spreaders, and soot blowers, in order to reduce water loss.

One need for mobile electric power plants arose in Russia, where the rapid advance of the Russian Army required repair facilities close to the fighting lines for damaged tanks, trucks, and other war equipment. The Soviet Government has already accepted a number of the 3,000-kw trains for this purpose, but these will also be useful in restoring the operation of water supplies, hospitals, and sanitation systems.

Earlier in the war, mobile power plants of 10,000-kw capacity were built for the United States Navy for use as an emergency power supply, and these have been operated successfully in the United States.

# The Fatigue Strength of Welded Joints

JONATHAN JONES

**Metals may fail in service as a result of repeated cyclical variation of stress. A research project, sponsored by the Welding Research Council of Engineering Foundation, has been conducted to investigate the endurance limits of welded joints, and a summary of the progress and future plans of the working committee are given in this article.**

THE FAILURE of a metal part in service by "fatigue" may be expected if:

1. The stress is not constant, but repeatedly varies in a "cycle" between a lower (minimum) and a greater (maximum) stress; the most severe cycle being that in which minimum and maximum are equal and opposite (full reversal).

2. The greater stress, maximum, is of a sufficient intensity.

3. The cycle is repeated a sufficient number of times, meaning hundreds or thousands or millions according to the severity of items 1 and 2. (For a more complete introduction to the subject see reference 1, which also contains an extended bibliography.)

If the range of stress in the cycle is not severe, or if the greater stress, maximum, is not great, the number of cycles to failure may be so many millions that for all practical purposes it may be considered indefinitely great.

For any given proportion of minimum to maximum, that is, for any particular type of cycle, the greatest value of maximum for which the number of cycles to failure may be considered indefinitely great is called the "fatigue limit" or "endurance limit."

For many structural parts it would be economically inadmissible to design so that maximum should remain below the endurance limit. In a railway bridge, for instance, in which virtually all parts are subjected to some sort of cyclical stress, maximum to minimum, it may be calculated that the total number of such cycles in say a hundred years of life, cannot exceed a few million. Judgment requires that the allowable unit stress be kept low enough to permit of those necessary millions, but not low enough for additional millions of cycles that will never occur.

For nearly a hundred years, beginning with Woehler in Germany, experimenters have published data on the endurance limit of metals, and on the numbers of cycles to failure on various cycles and with various values of maximum. In general, the fatigue values for various steels have varied in proportion to the ultimate static tensile strength. These published values were based on specimens of uniform and, usually, polished form, and are unattainable in metal subject to the defects inherent in any form of fabrication for use.

Such defects must obviously exist in any structural joint. In a welded joint they may be due not only to weld defects such as porosity, inclusions and undercut, but without any of these they would exist in the change of exterior form at a weld, just as they exist at the shoulders on an axle.

Eight years ago a committee of the Welding Research Council was organized to obtain some usable data for the benefit of structural designers; the most definite objective was to supply the data needed by a committee of the American Welding Society which was writing a specification for welded bridgework.[2] The laboratory work, which still continues, has been carried out at the University of Illinois. Complete experimental data have been published from time to time by the laboratory, and condensed reports directed specifically at structural designers are issued by the committee.[3]

A summary of the results obtained to date will best be appreciated on the basis of a diagram explained in the committee's Report No. 2.

When a test is started on a given specimen on a given cycle (say zero-to-tension), a unit stress (maximum) is imposed which it is hoped will cause failure at a certain number of cycles. Of course the failure occurs at some quite different number. In the committee's program, usually six duplicate specimens are tested on the same cycle, three aimed at 100,000 repetitions

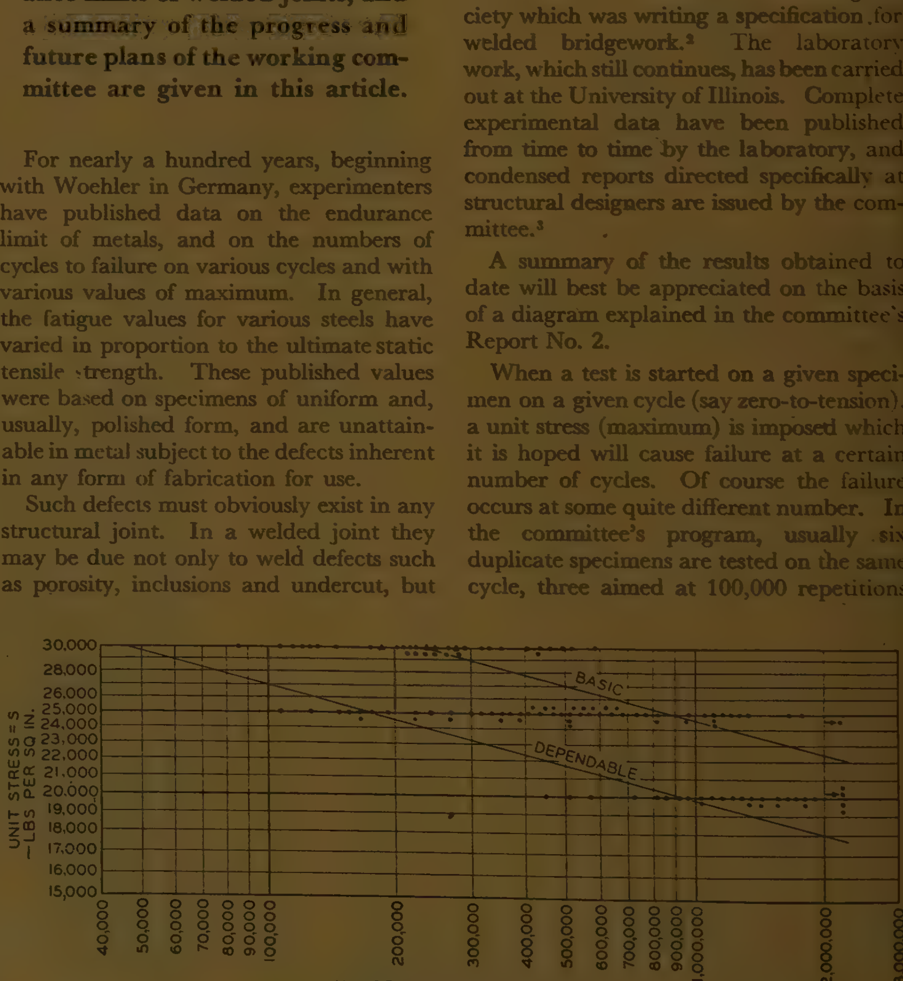



**Figure 1. S/N relationship for butt welds in seven-eighth-inch steel plate**

*Cycle zero to tension*

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nd three aimed at 2,000,000 cycles. Due o the unavoidable though usually non-letectable variations between supposedly dentical specimens, the result is six values of maximum (called $S$), three low and hree high, and with each a number ($N$) of actual cycles to failure, which numbers vary disappointingly from one another and rom the 100,000 or 2,000,000 objective.

It has been found, over many tests of plain steels, that such associated $S$–$N$ test values, if plotted on log–log paper will conform rather well to an inclined straight line for $N$ between say 50,000 and say 4,000,000. It is convenient, and cannot create great error in application to design, to assume the same to hold true for welded specimens of a class. Acting on this assumption, the six (or more or fewer) $S$–$N$ test results from a given series are plotted as points on log–log paper (with $N$ for abscissa and $S$ for ordinate), and a straight line is passed through the center of the left-hand (small $N$) and the center of the right-hand (large $N$) group. The intersection of this line with any $S$ horizontal gives the number of cycles that should be resisted, on the average, with that $S$ as maximum. The intersection of this line with any $N$ vertical gives the maximum unit stress $S$ which should, on the average, be endured $N$ times and should then cause failure. Owing to the scatter in the data, this procedure must not be thought of as rigorous—only as useful for purposes of safe design.

Figure 1 is a condensation of a part of the data thus plotted and employed.

In Figure 1, each solid triangular symbol represents a test result on a "basic" X-rayed series of butt-welded specimens of seven-eighth-inch plate (ASTM A7, 60,000–72,000 tensile), tested without stress-relief and without removing or smoothing the weld convexity; the test cycle being from minimum equals 0 (full release of load) to maximum equals the tensile unit stress plotted. The upper sloping line is an approximate average through these points, and permits, as has been described, the scaling off of the "basic," or best obtainable $N$ for a given $S$, or $S$ for a given $N$, for butt welds of this character.

Each other plotted point in Figure 1 represents a test result from some one of numerous other series that were subsequently tested, using the same form of specimen, again without stress relief or improvement of as-welded form. These several series, however, were commercially obtained from various shops and field operations, and made by many qualified welders and in various positions. The scatter of these results is manifest. The lower sloping line in Figure 1 is not an average, but is what the committee after due deliberation voted to announce as "dependable." A designer is, in the opinion of the committee, justified in assuming that a butt weld in seven-eighth-inch A7 plate, made under American Welding Society specifications by a qualified welder but not stress-relieved or improved in external form, if subjected in service to a tensile force fully released and reapplied, may be depended upon not to fail at an $S$–$N$ relationship below that represented by this line. If, for instance, he requires resistance to 1,000,000 repetitions, he finds that he can depend upon a maximum tension of 19,800 pounds per square inch, to which he will apply a "factor of safety" of his choosing.

While great accuracy for this method of interpreting the test data has already been disclaimed, it will be noted from Figure 1 that a considerable variation between the values of $N$ obtained for a given setting of $S$, makes comparatively little difference in the position of the "average line," hence in the fatigue strength $S$ that will be scaled off by the designer at his particular $N$.

Additional data are summarized in Figures 2 and 3. Figure 2 covers testing of butt welds on the cycle zero to tension, and Figure 3 on the cycle minimum equals maximum, or complete reversal. Only the averages are shown.

In Figure 2, cycle zero to tension, line 1 represents a few tests made on plain plate with mill scale planed off, and line 2 a larger number made on plain plate with the mill scale on. The contrast shows the effect of mill scale as a stress-raiser or stress concentration. These plain plates had the same critical area (five by seven-eighth inches) as the butt-welded plates.

Lines 3 represent butt-welded plates with the weld convexity planed off flush with the plate, specimens 3*a* being stress-relieved and specimens 3*b* being not stress-relieved. Line 4*a* represents butt-welded plates with the weld convexity undisturbed, stress-relieved. Line 4*b* represents the same but not stress-relieved, and is the same as the upper line in Figure 1.

In Figure 3, cycle complete reversal, the significance of the several lines is the same as for lines of the same number in Figure 2. Line 1 is missing, as no reversal tests were made on plates unwelded and planed.

All of these lines represent the averages of the respective tests; and all are on "basic" specimens, that is, specimens X-rayed to ensure highest degree of soundness in the welds.

The several variants represented by lines 1 to 4*a* were made only to show their relative effects on welds of one quality. These variants were not repeated on the several series of "commercial" butt welds recorded in Figure 1, as they have no commercial

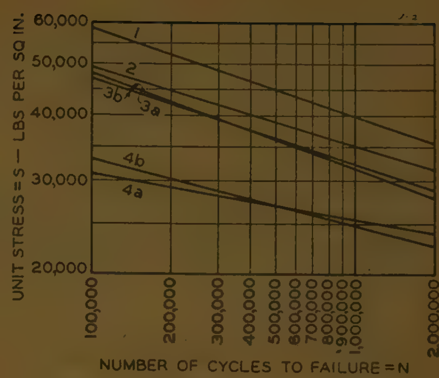


**Figure 2. Testing of butt welds**

*Cycle zero to tension*

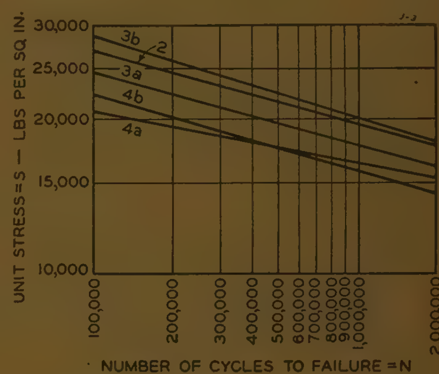


**Figure 3. Testing of butt welds**

*Cycle minimum equals maximum, or complete reversal*

place in bridge and building practice. Al "commercial" welds were tested with weld convexity undisturbed and in not-stress-relieved condition.

Further tests were made on butt-welded specimens of the same form, size and material as the preceding, in which the major stress, maximum, was compression instead of tension. On the cycle of complete release, or zero-to-compression, no failure was obtained at over 4,000,000 cycles with a compressive maximum practically equal to the specified maximum yield point of the material. Therefore in compression members in which minimum is also compressive, fatigue failure need not be considered a possibility.

On other cycles in which minimum was tensile and maximum was compressive, the fatigue strength fell off as minimum increased in intensity. This is shown in Table I.

It is not possible, for lack of machines, time, and money, to make such tests on every cycle of minimum to maximum that

**Table I. Number of Cycles Endured Under a Fixed Compression and an Increasing Tension**

| Stress Cycle, Kilopounds Per Square Inch | Number of Tests | Number of Thousands of Cycles for Failure | |
|---|---|---|---|
| | | Minimum | Average |
| −32.0 to 0 | 2 | 4164.4 (no failure) | 4710.9 (no failure) |
| −32.0 to + 8.0 | 3 | 165.6 | 313.6 |
| −32.0 to +16.0 | 3 | 23.7 | 36.0 |
| −32.0 to +24.0 | 2 | 13.6 | 15.9 |

can occur in a structure. However, with reasonable values on the cycles (1) complete reversal, (2) zero to maximum, and (3) maximum-to-one-half maximum,* the committee has felt that the many intermediate cycles can be handled by interpolation. The method is illustrated in Figures 4 and 5.

Figure 4 is for butt welds in structural members in which the principal stress, maximum, is tensile; Figure 5 for those in which it is compressive. The respective curves represent "dependable" values, as announced by the committee, to which safety factors will be applied by the designer.

To construct Figure 4, the "dependable" values at $N$=100,000 and $N$=2,000,000 are obtained from the previously constructed curves such as Figure 1, for the test cycles just mentioned. These are indicated by circles in Figure 4. To construct Figure 5, "dependable" values are similarly obtained, for the test cycles listed in Table I.

Instead of 100,000 and 2,000,000 cycles, any other number of cycles could be chosen as critical for a certain structure or member, and another line drawn. It so happens that 100,000 and 2,000,000 are considered to be reasonable critical numbers for two different types of bridge member, those stressed by all parts of a long load and those stressed by a single heavy axle, respectively.

In Figures 4 and 5, abscissas are minimum, and oridnates are maximum, to the indicated scale. To the right of the vertical line, minimum and maximum are of the same sign; to the left, there is reversal. To use such a chart consider, in Figure 4, a member for which the stress sheet shows total stresses minimum (dead) = −40.0 kilopounds, maximum (dead plus live plus impact) = +120 kilopounds. The ratio minimum/maximum = 1/3. Construct the line shown dotted, on a −1:3-slope. Its intersection with the upper line scales 22,200, and shows that the butt weld in this member should fail at 22,200 pounds per square inch if the maximum load cycle is repeated 100,000 times. The intersection with the lower line scales 14,800, and shows that the same weld should fail at only 14,800 pounds per square inch if the maximum load cycle is repeated 2,000,000 times. None of this information can in the nature of things be highly accurate, and it calls for the use of reasonable "factors of safety"; but it does afford the designer a possibility of reasonable balance over the various members of a structure. The committee on specifications for welded bridges of the American Welding Society is already building its design unit stresses around these data;

* When the cycle maximum to one-half maximum was tested in the "basic" series, with maximum tensile, the fatigue strength at 2,000,000 cycles was found to be above the static yield point. Therefore this cycle was not tested on the "commercial" series, and is not shown in Figure 4, as the static yield point replaces it as the controlling factor for design.

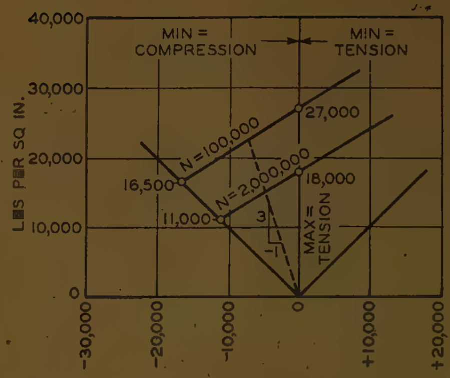


**Figure 4. Dependable fatigue strength of butt welds in seven-eighth-inch medium steel plates**

*Principal stress tensile*

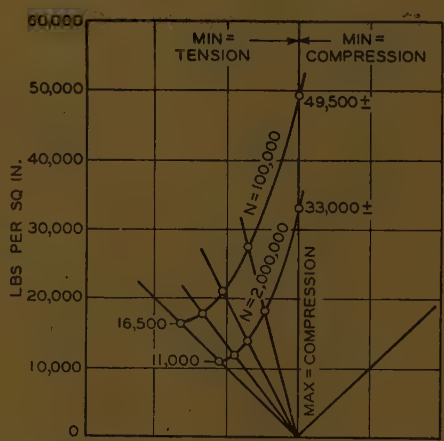


**Figure 5. Dependable fatigue strength of butt welds in seven-eighth-inch medium steel plates**

*Principal stress compressive*

and has developed, as explained in the appendix to its specification,[2] some design formulas which make the application simpler than, though mathematically identical with, the method of this paragraph.

The committee has in mind further tests of butt welds, including (a) welds in low-alloy steel and (b) welds in, instead of at right angles to, the direction of the stress.

The committee has made hundreds of other tests, involving the failure in fatigue of fillet, plug, or slot weld splices for plate members, and is commencing now to test flexural members such as rolled beams with welded cover plates, and three-plate welded girders, also various forms of welding used in reinforcing old bridges. It is operating, at the University of Illinois, four machines with a capacity of 200,000 pounds in tension or compression, and two with a capacity of 50,000 pounds.

The committee has not yet published any report of conclusions, other than on butt welds, but hopes in the near future to publish one on fillet, plug, and slot welds in bridge steel. This topic has required more time and care than were at first anticipated, because of the discovery of a relatively very low fatigue efficiency for material connected by fillet welds. Thus, when plates are spliced with double-lap fillet-welded splices, and tested on a cycle of zero-to-maximum, the main material may develop tensile cracks after 100,000 repetitions at 20,000 pounds per square inch or after 2,000,000 repetitions at only 9,000 pounds per square inch. This situation cannot be remedied by additional welding, since that does not reduce the stress concentration in the plate itself. Similarly, an I beam reinforced with top and bottom cover plates, fillet welded along the sides and across the ends, when tested on the cycle 1,000 to 33,000 pounds per square inch in the beam, failed after only 17,500 cycles by cracking across the beam flange just ahead of the welding.

Present test programs are aimed at developing as much efficiency as is commercially possible in fillet-welded material, and determining what that efficiency is. It is certain to prove far lower than for butt-welded connections.

In applying such data, it would be possible to commit gross extravagances by overestimating the extent of its applicability. On bridges, the specified loads are rarely present in the combinations and positions envisioned in the calculations for maximum stress in the heaviest members. When present, they are not necessarily of the maximum specified intensity. A small reduction in the maximum load makes a large increase in the number of cycles endured before failure. If the assumptions of the designer as to the maximum loads, and as to the number of times they will occupy the bridge in its lifetime, are held down closely to the true probabilities, extravagantly low unit stresses will not be called for by the test results. Undoubtedly, however, the specification for a bridge which contemplates the use of fillet-welded main connections, must go into these factors even at the cost of apparent complexity, or there can be either danger or waste.

The committee of the Welding Research Council is not setting up specifications for design. But it does hope, over the near future, to publish in the forms outlined in this article, all the factual data which the writing of such specifications requires.

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# IV—Expanding Horizons

DAVID C. PRINCE
FELLOW AIEE

**There is no saturation point in sight in the electrical industry, declares this electrical manufacturer; he indicates that we have hardly made a start in the use of electric power by mankind, but must find new and better ways of acquiring knowledge and putting it to work.**

WE electrical engineers have too many developments in progress to subscribe to the sentiment that we live in a mature economy, even though we have been told we do. We feel confident that the future is going to flow on from the past. We have our natural laws through which we work. Most of us do not expect to break the laws of conservation of energy, at least not right away. We think that 100 per cent efficiency is a safe limit for the time being. But we can see that lots of these laws can be interpreted in another way. Laws are not necessarily limiting. Man-made laws are limiting, but nature's laws are partly for the purpose of directing us to the things that we can do instead of limiting us to the things that we cannot do. So, we take these laws, and we see what we might conceivably do in the way of using them as guides for the future.

We can arrange technical developments approximately in order of time. A great many technical developments that are in process right now have been stimulated much more than they would be ordinarily by the urgency of war, and we will be able to call upon them in the immediate postwar years. There are developments that we already know the beginnings of and others that we do not, in general, know too much about, but which will be made known as soon as the cloak of secrecy can be raised.

We have generators and transformers so high in efficiency that for the time being we need expect no large increase in their efficiency. However, that does not mean that we have come to the end of the road in those things. We still can make them smaller and can develop new materials to make them better in other ways than merely increases in efficiency. We are learning a good deal about how to make them. As we reach a point where a given piece of machinery can be standardized in some way, then it becomes possible to make a new set of advances which will reduce the cost of that machinery and thereby make it more available to mankind.

Some very conspicuous examples of that sort are coming to light as a result of the war effort. For instance, for the first time in history we have 30,000-horsepower steam turbines in quantity production. The result of that quantity production in the amount of productivity per man-hour can be measured. For instance, estimates were made on the initial number of man-hours which were required to make the turbines—we will call that 100 per cent. After production had gone on for five months, the required number of man-hours had dropped to 80 per cent. After production had gone on 20 months, it took 71 per cent as many man-hours to produce the turbine as it had taken before the thing was standardized and put on a quantity-production basis. We know that when we can say, for the time being, a thing is good enough, then we can put production techniques to work on it and reduce the cost by a radical extent.

It has been supposed that motors, according to calculations, might be saturating the field. Soon we might get all we want, and, since we know that many very old motors are still running well and giving satisfactory service, the motor business would be finished. That has not happened, however. If you look at the statistics, you will find that in 1929 about 79 per cent of manufacturing processes were electrified with motors—that could be electrified with motors. In 1939, ten years later, that fraction had reached 86 per cent.

The growth of electrification with motors cannot be measured by those ratios, however, because during that period the total amount of manufacture increased by a considerable degree. Also, the increase in the use of motors is not delineable by increase in electrification only, because we are discovering lots of things that can be done with motors that we did not know about previously.

Perhaps a conspicuous example of that is in the field of aeronautics. Originally, an airplane had one engine in it. The engine was driven by gasoline, and it had electric ignition. That was the only place where electric power was used, except for landing lights and a few similar applications.

Now, there are four-motored bombers which have over 185 motors in them, performing different kinds of functions. With the possibility of that sort of development, it is useless to talk about saturation, either in the number of motors or the uses to which they can be put.

We have other developments which lend themselves in the direction of more uses in the flexibility of our goods. For instance, in the past we have had hydraulic devices utilized for the control of such things as the big guns on the naval vessels to pro-

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Essential substance of an address presented at the Institute's 60th anniversary observance during the AIEE North Eastern District meeting, Boston, Mass., April 19–20, 1944.

David C. Prince is vice-president in charge of application engineering, apparatus department, General Electric Company, Schenectady, N. Y. and past president, AIEE.

duce precise movements in elevation and azimuth. Now, we find by the application of well-known electrical principles, d-c power can rotate not only the turrets on vessels but also the turrets on a lot of airplanes where a higher precision and speed are used. This device is called an Amplidyne.

The Amplidyne can be used, too, for a good many other functions requiring graduated and modulated control of considerable power and yet responsive to a small force. We have motors as light as 25 pounds for a 35-horsepower motor and rotational speeds as high as 120,000 rpm. We have hardly begun to explore the uses of such motors.

Of course, uses of electricity are not being limited simply to motor devices. We also are using electricity more and more for a lot of other purposes. A large part of our alloy steel production is from electric furnaces.

We hear, also, about high frequency. That comes into the story of electronics, and electronics is able to do a great many things. We find, for instance, that, when it is desirable to introduce heat into the middle of a body, it can be done by high frequency, by eddy currents in the middle of the body, or by electrostatic effect. Or we can take the outside of a metal part and bring it quickly to a high temperature and chill it so as to cause a hardening of the surface. When we harden the surface and put it under compression, we find it is more or less immune to fatigue which starts in scratches on the ordinary surfaces. Whereas in the past it has been necessary to go over the parts of airplane engines with a great deal of care, now, if we have the surface under compression, it may be much less necessary. Perhaps, by small application of engineering and electricity we can replace a large amount of human effort now expended in polishing, and other processes.

The electrical genie also is probing into the region of activity in which man's brain has been depended upon largely in the past. We have cyclic processes in the oil refinery business where hundreds of valves have to be opened, one for a while, then closed, then another and another. We have electric brains by which those things can be all operated in sequence, so that the deadening monotony, as far as the human worker is concerned, is lessened; and a much more conscientious job can be performed—better than if we had to depend upon our memories.

In measurement, electricity can do things that have never been possible to do before at all. We measure the quantities of the volts—amperes. In addition, by virtue of the application of electronics, we can measure thickness and tension, and we can use photoelectric effect to perform operations formerly performed by the human eye. We can measure sound. In fact, the only ones of our five senses which have not yet been measured are taste and smell; and we have every reason to believe that, if there is a good reason why measurement of these is needed, a method can be found to do it.

The use of electricity in local traction seems, for the moment, to have passed its peak. Some further expansion in railroad electrification is in prospect. Technically, the way is open for further progress. If we accept existing systems as satisfactory, we can apply the quantity-production techniques to reduce costs greatly. If, on the other hand, new techniques are desired, we know how to develop those too. We could have single-phase-rectifier locomotives for 25 or 60 cycles or even high voltage (20,000 volts) direct current.

The Diesel-electric locomotive, of course, has a lot of electric power in it. We know there are something like 30,000 steam locomotives and only a few hundred Diesel-electric ones. These latter are developing rapidly, however, and so there are many opportunities for technical advances, and changes to be made here.

In shipping there are many places where electricity might be used and has not been used before. For a number of years we have had instances of electric propulsion. Ships and ferryboats and tugs can operate with this electric propulsion. During this war we have gone further still. A large percentage of the destroyer escorts and a good many tankers are electrically driven vessels. On the tankers electric power is employed not only to drive the ship but also to handle the cargo. This application may well be expanded to permit our cargo vessels to compete with those of lower labor standards.

Lighting is one of the most universal of our applications of electricity. In the lighting fields, we still can look forward to a considerable advance. At the end of World War I lighting experts were quite tickled to find places where they could apply an intensity of five foot-candles. Now they are talking in terms of 50, 75, and 100 foot-candles in a factory, and nobody questions it. So, as far as we know, there is no saturation point. I asked a lighting expert if we are likely to get any better lights, and he said: "Our present efficiency is 20 per cent. I don't know just how improvement is going to be made, but there is plenty of room for it." So there is an opportunity for someone to make radical advances in this field.

In the specific field, where electronics is used for communication, we know that there are many developments all ready to be offered to us. Frequency modulation was just coming into use before the war. We have had television for quite a while, and we know that the companies manufacturing such broadcasting equipment can make it "when," "as," and "if." So, it will probably not be very far in the future before there will be many television programs and receiving sets to receive them.

All of those things are very definitely in the cards. We can have many of them right after the war, if the public demand is such that we want to bring them out.

We have new materials and new ways of doing things, and it is hard to predict an end to these possibilities. For instance, a number of years ago the older engineers will remember that there was a long argument as to what the best frequency would be for electric-power transmission. They argued from 133 to $16^2/_3$ cycles, and earlier systems employed various frequencies. Sixty cycles is standard now, but it is not necessarily a final thing. On some ships we use 93 cycles, I believe, and by increasing the number of cycles we can decrease the size of the apparatus. In fact, to make motors to drive airplane models, we have gone to 180 cycles, and even as high as 400 may be a standard airplane frequency. As a result, we have some motors which approach one pound per horsepower. That permits the use of these extraordinary electric motors in lots of places where we had supposed before they could not be used. And so, electric energy may be used in a great many new places.

One of the things served up to us periodically by the newspapers is the possibility of wireless transmission of power. At the present time wireless transmission of power has been rather inefficient. However, we now know a way to transmit power through the air, and we know we can transmit this power with considerable efficiency for a considerable distance with wave guides but without the use of wires. That does not necessarily mean that we will do it. The question is: Is that a thing that is going to pay its way in terms of human service? We can also use high-voltage direct current, if we want to. When the systems were being developed, before our a-c transmission had reached anything like its present development, high-voltage d-c systems were used in some places abroad. Now, with our electronic techniques, we could revive them again—but, I say again, *if* we find we want to do it as a service to mankind.

There is another field still further into the future. It may never bear fruit, but it is a possibility. Some people have said: "Why can't we have a storage battery much better than we have now, one that can be charged up to provide light and power for summer camps?" That question has been propounded to the chemists and the scientists generally, and they have said: "No, you can't have that, because we have looked the whole table of chemical elements over, and we found none that give much more electric energy than you now have."

However, there are other possibilities. If we had a pound of radium, it would gradually disintegrate, throwing off rays of one kind or another. That would be a source of primary energy that would compare favorably with any other.

We know there are artificial radioactive substances. When the energy is radiated, the material changes from a material that is heavier back to a lighter one. So we know the possibilities of the change of matter into energy; and, although we do not know just how to get the matter to enter those changes, or how to control the changes, we do know how much energy there is. That energy is equivalent to 11,300,000,000 kilowatt-hours per pound of material. Of, if we have to use that power in the form of heat, it corresponds to 3.85 times $10^{13}$ Btu per pound.

We therefore have this potentiality. When people worry about the eventual exhaustion of all of our oil resources, just remember that here is a potential supply where one pound will give you 2,000,000,000 times as much heat as the best high-octane gasoline.

So, there we have a picture of what we may get in the way of technical developments. We know there are a good many more that have not been suggested here, although when we look back later we will see that the beginnings of knowledge about these other developments were here too. Every time an invention is made, some of you could say: "I should have known that. I should have done that."

In the realm of education, we are very fortunate that Maxwell conceived the idea of not limiting physics to making experiments and measuring and getting qualitative information from them, but making an actual mathematical analysis of what is going on. When it progressed from the purely scientific to the actual development of the practical art, we found people like Steinmetz and Lamme ready to carry on in the Maxwell tradition. They were to apply mathematics to electric-machine design and both reduce the labor and improve the accuracy of predicting machine performance.

When problems got too complicated for hand-power mathematics, the various forms of network analyzers were developed; and for those fields where the phenomena might not be linear, the Bush differential analyzer was developed. These forms of mechanized mathematics have enabled our electrical industry to advance far ahead of all others in replacing the purely empirical by an analytical approach.

These tools can now be applied to other forms of engineering. By these means many analyses will be possible which never were before. For instance, an airplane designer came to Schenectady and worked two weeks on a stress analysis. He made calculations on the time he had saved; he had done 17 man-years of work. Think of what that means, in applying the techniques that have been worked out, in the knowledge of how to do such things.

In making these advances, we have acquired some responsibility to communicate the techniques to the other engineering groups who have not had the same advantages up to this point. Of course, not only does that give us that responsibility, but it also brings home to us another thing. We have some responsibility for the acts of our brain children. I don't believe any engineers can justly be charged with being responsible for the war just because the things they made are being used for destruction; but at least there is a warning to us to make it our business to consider what we are going to do with the technical developments and to see whether we can direct them into the channels serving mankind instead of destroying mankind. In other words, we have an obligation to learn more about electrical engineering, and then we have an obligation to find ways to put that knowledge to work. And we have a further obligation to consider how that knowledge may be used and to see that it is used in a way to benefit mankind instead of bringing about destruction.

Now, how can we add that knowledge to the already overburdened industries. It seems to me that there is a considerable opportunity for a research of quite a different kind from a purely technical research. We know that in the Army training, in just a few weeks, knowledge has been imparted to men which has enabled them to do things which ordinarily they could not have done without taking a four-year college course. We know another thing as a result of this war—and we should have known it as a result of the last war—in peace times we have been in the habit of saying that everybody should have a four-year course; and then every little while, because of the pressure of unemployment, or something of that nature, we think that perhaps the course should be increased to six or eight years. Actually, these young men have been able, not after four, six, or eight years of college training, but after a few weeks' training, to take these mechanisms of a highly technical nature and get out of them the functions called for.

We have the obligation not only of getting the knowledge and using it in the way that I have described, but also of finding ways and means by which it may be imparted to young men in a shorter time, so that they can apply it for their own benefit and ours. We must find a way for those men who are capable of leadership to take the reins and go ahead. Our war experience has shown us there are many capable leaders. Look at the decorations on the shoulders of the men in the service; it is not necessary to become 50 years old before becoming a competent leader. That, also, is one of the possibilities to be considered by people having charge of the educational phases of our electrical engineering.

We know that there is no end to the learning; but we have to have new ways of learning it. In other words, there is no saturation in sight, but we must find new and better ways of getting the knowledge and putting it to use. The technical advances and the educational advances undoubtedly await us. We will have, in addition, the advances in the use of our knowledge in the things that electricity can do.

I assembled some figures on the extent to which our electric power is being used at present. I found that the most common single thing in the hands of the public is the electric iron. Of all the people who have electricity, 93.7 per cent have electric irons. Next on the list is radio receivers, 87.5 per cent. When we get down to electric ranges, we are already down below 13 per cent. And when we get down to some of the other things we are beginning to hear about, such as dishwashers, deep-freezing units, air conditioning, and so on, they do not appear in the percentage column at all; they are still less than one per cent, and we have no statistics on them. But, we can look forward to developments from many of these things; and even in the lines most highly saturated there is still quite a bit of room to advance because, although we have 93.7 per cent electric irons, still there are to be 1,500,000 new homes each year and each of those should have electric irons. We have a long way to go even in the houses already wired.

We read a good deal about the houses not wired. As a matter of fact, the urban homes are 94.8 per cent wired. Presumably, they all have electric lights, and most of them have the other electric devices. In the rural nonfarm homes 83 per cent are wired, but the other farm homes are down to 36.1 per cent, so that only one out of three of these places has electric power, and the percentage of full use of electric power on the farm is much lower still.

As to what the possible future use of electric power by industry is, we have no way of telling. When we increased the speed cutting tools through high-speed steel, we thought we had done the job, but with cemented tungsten-carbide tools such as Carboloy we increased it again. When we increased the amount of power in continuous-strip steel mill, we thought we were doing a job; but we find we can set that up again. It just seems possible to increase indefinitely the use of electric power both to the private consumer and to industry. We know that the United States leads the parade in the use of energy per person; we know that all of Europe has been far behind us. Then, you get into South America, Africa, and China, and a start has hardly been made. We can be sure we have not approached saturation. Indeed, we have hardly made a start in the approach of the use of electric power by mankind. There are paths leading into the future of technical development, paths to new methods of learning and teaching electrical techniques and training our leaders; paths into more widespread uses of electricity in the service of mankind.

## The Future of the Institute—*A Message From the President*

I desire first to thank you for the great honor you have bestowed upon me in electing me your president. I am looking forward to my term of office as a further opportunity to serve the Institute and shall do what I can to maintain the high traditions associated with the office.

The Institute is celebrating its 60th anniversary and it may be a good time, therefore, to ask ourselves if it has carried out the purpose to which it was dedicated by its founders—"*the advancement of the theory and practice of electrical engineering and of the allied arts and sciences, and the maintenance of a high professional standing among its members.*" To find the answer, we have only to go into any library and look through a few of its Transactions or examine a few of its Standards, and there can be no question that the Institute has fully carried out its avowed purpose. It must be a tremendous satisfaction to all of us to look back at the solid record of achievement of those 60 years. Nevertheless, it is true that any organization must move with the times or die, and so it is probably also fair to ask ourselves if the purpose of the Institute has run its course?

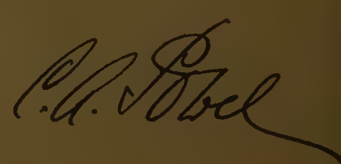
The answer to this is an emphatic "no." The electrical industry is still in its infancy, and it is sure that there will be a steady "advancement of the theory and practice of electrical engineering and of the allied arts" for many centuries to come. I visualize the Institute celebrating its 500th anniversary. Why not? We read of old-world universities celebrating even their 800th anniversaries, and their fundamental purpose has not changed in the interval, even though they may have changed the methods of carrying on their purpose. We must, therefore, see to it that the Institute be kept on the main highway which stretches still so far into the distance and not be diverted into branch roads where after a few years its main purpose and reason for existence will be lost in the swamps of other and unrelated issues.

And what of the immediate future? The year ahead of us should be one of at least partial liberation—we should be able during the coming year to count on a cessation of hostilities in Europe if not in Asia. It is apparently the plan of the Government when this happens to release men gradually to normal employment. These men will be of various types. Some will be older men ready to go back to the work they dropped before they were inducted, some will be young men who did not have an opportunity of completing their technical training in a normal manner, and others will not have started their college careers at all.

Industry must find a way of absorbing the older men as they are discharged from the Armed Forces. This can probably be done with the elimination of women temporarily holding men's jobs and of men who have reached the age of retirement. Industry should in addition recognize its responsibility in helping these men bridge the gap in their technical experience caused by their term of service by providing suitable refresher courses.

Men not drawn from previous industrial occupations and having sufficient ability to justify college educations deserve and must be given an opportunity of acquiring such an education. The colleges will be confronted with problems arising from, first, transition from accelerated to normal course; second, the necessity of providing refresher courses for those men who have had as yet no opportunity of applying their college education outside of the services; and third, the complication brought about by the wide range of age of the freshmen classes. The Institute can assist the electrical educators, who make up such a large part of our membership, in the preparation of curricula for such students.

The schools should call on industry for any co-operative assistance they feel they need. Industry is vitally interested because its future is determined by the quality of the men graduated. The Federal Government will bear part of the expense of this transition program and it behooves us to make our plans so well that there can be no cause for the Government to make them for us.



Charles A. Powel, President AIEE 1944–45

# Los Angeles Technical Meeting to Be Held August 29 September 1, 1944

**Because of serious travel congestion, the Office of Defense Transportation has requested the cancellation of conventions. However, as the program originally planned for the Pacific Coast technical meeting is predominantly devoted to electrical applications to military aircraft, the meeting is to be held as the Los Angeles technical meeting. Members who do not have a direct interest in the papers to be presented should give serious consideration to travel conditions and whether or not their attendance would really aid the war effort.**

The Los Angeles technical meeting will be held with headquarters in the Hotel Biltmore, August 29–September 1, 1944. In view of the extensiveness of the aircraft industry in the vicinity of Los Angeles, the program is principally devoted to electrical applications to military aircraft to aid the war effort. The papers will present various problems in connection with research, design, and development of electrical apparatus on aircraft which has to perform throughout the range of temperatures encountered in the tropics to the very low values at the high altitudes.

TECHNICAL SESSIONS

Fifteen of the 19 sessions arranged deal with aircraft electrical applications. Papers of broader interest have been scheduled in the morning sessions, whereas those which deal with more highly specialized subjects, such as automatic pilot control and instruments, motors, brush wear, radio, lighting, and high-potential ignition systems, have been scheduled in afternoon sessions. Several British papers will give valuable contemporary experiences. In addition to the aircraft sessions technical sessions on protective devices, power transmission and distribution, and industrial and marine applications will be held.

HOTEL RESERVATIONS

The Biltmore Hotel has been selected as meeting headquarters. Additional accommodations have been obtained at the Savoy, San Carlos, and Clark Hotels, all within two blocks radius.

All room reservations should be made through the hotels committee by means of the card which was enclosed with the announcement of the meeting and sent to the nearby territory, or by writing to R. F. Gheen, chairman, hotels committee, Ohio Brass Company, 417 South Hill Street, Room 1046, Los Angeles 13, Calif. Because of the great demand for hotel facilities reservations made by the committee will expire August 15.

Biltmore Hotel has no single rooms available; members should include name of person desired to share room, when making reservation. Clark Hotel accepts no single reservations. All rooms must be vacated prior to noon, September 2.

Return transportation should be arranged in advance.

ADVANCE REGISTRATION

Members who will attend the meeting should register in advance by filling out and mailing the advance registration card which accompanied the meeting notice. This will permit the registration committee to have badges ready and prevent congestion at the registration desk. In accordance with regular practice a registration fee of two dollars will be charged all nonmembers excepting Enrolled Students and the immediate families of members.

LOS ANGELES TECHNICAL MEETING COMMITTEE

The members of the Los Angeles technical meeting committee are as follows:

T. M. Blakeslee, *general chairman;* P. L. Johnson, *assistant general chairman;* E. S. Condon, *secretary.* The chairmen of subcommittees are: P. L. Johnson, *technical program;* G. R. Woodman, *registration;* R. F. Gheen, *hotels;* Bradley Cozzens, *arrangements;* E. L. Bettannier, *reception and transportation;* Fred Foulon, *aircraft activities;* E. W. Morris, *electronics activities;* F. W. Maxstadt, *student activities;* A. D. Brown, *finance;* J. H. Vivian, *publicity;* P. L. Savage, *inspection trips;* R. A. Hopkins, *educational.*

**Table I. Hotel Rates**

| Hotel | Single | Double | Triple | Suites |
|---|---|---|---|---|
| Biltmore | | $7.00 to $10.00 | | $12.00 to $20.00 |
| Savoy | $2.75 to $4.40 | 3.85 to 4.40 | | |
| San Carlos | 3.00 to 4.00 | 3.00 to 4.00 | | |
| Clark | | 5.00 | $6.00 | |

# Tentative Technical Program

**● ABSTRACTS of most papers appear on pages 309–15 of this issue, pages 145–6 of the April 1944 issue, and page 227 of the June 1944 issue.**

**● PRICES and instructions for procuring advance copies of these papers accompany the abstracts. Only numbered papers are available in pamphlet form.**

## Tuesday, August 29

### 9:00 a.m. Registration

### 10:15 a.m. Opening of Meeting

**J. M. Gaylord, presiding**

Address: **Brigadier General Donald F. Stace,** United States Army, commanding general, Army Air Forces Matériel Command, Western District

Address: **C. A. Powel,** president, AIEE

Report on District prizes

### 2:00 p.m. Electric Motors for Aircraft

44-197. Requirements for Aircraft Electric Motors. **E. R. Siefkin,** Lockheed Aircraft Corporation

44-210. Design Considerations of 400-Cycle Aircraft Motors. **M. B. Sawyer, Sr.,** Sawyer Electrical Manufacturing Company

44-201. Functional Design of Aircraft Electric Actuator Equipment. **C. E. Gagnier,** North American Aviation, Inc.

44-205. Problems in Applying Protectors to Electric Aircraft Motors. **L. W. Buell,** Spencer Thermostat Company

44-191. Inherent Overheating Protection of D-C Aircraft Motors. **C. G. Veinott,** Westinghouse Electric and Manufacturing Company

### 2:00 p.m. Aircraft Radio

44-180. Alternating Versus Direct Current for Aircraft Radio Power Supply. **D. E. Fritz, C. K. Hooper,** Westinghouse Electric and Manufacturing Company

44-211. Very High-Frequency Radio-Noise Elimination. **T. B. Owen,** Douglas Aircraft Company, Inc.

44-209. A New High-Frequency Capacitor. **W. M. Allison, N. E. Beverly,** Sprague Electric Company

44-213. Radio-Noise Elimination in Military Aircraft. **G. Weinstein, H. H. Howell, G. P. Lowe, B. J. Winter,** Boeing Aircraft Company

### 2:00 p.m. Aircraft Ignition Systems

44-234. Analysis of High-Frequency Ignition Circuits. **A. W. Robinson, Jr.,** General Electric Company

44-189. Design of an Ignition System for an 18-Cylinder Aircraft Engine. **J. R. Harkness,** General Electric Company

## Wednesday, August 30

### 9:30 a.m. Protective Devices

44-214. Field Determination of Current-Transformer Errors by the Secondary-Voltage Method. **E. C. Goodale, J. I. Holbeck,** Bonneville Power Administration

44-215. An Analysis to Determine the Optimum Bussing Arrangements and Transmission Capabilities at Grand Coulee. **B. V. Hoard, G. W. Bills,** Bonneville Power Administration

44-192. 230-Kv High-Speed Reclosing Oil Circuit Breaker. **A. C. Schwager,** Pacific Electric Manufacturing Corporation

44-216. A New Distance-Type Relay With Adjustable Characteristics. **S. L. Goldsborough,** Westinghouse Electric and Manufacturing Company

### 9:30 a.m. Aircraft—General

44-217. Brief Survey of Power-Supply Developments on British Aircraft. **P. W. Carter,** British Air Commission

44-196. Airline Aircraft Electrical Equipment Maintenance. **W. A. Petrasek,** American Airlines, Inc.

44-218. Aircraft Electrical Horizons. **F. W. Godsey,** Westinghouse Electric and Manufacturing Company; **W. L. Berry,** Hughes Aircraft Company; **T. B. Holliday,** United States Army Air Forces

† Wiring Systems—British

### 12:15 p.m. Luncheon Meeting

### 2:00 p.m. Aircraft Electricity

44-81. A-C AND D-C SHORT-CIRCUIT TESTS ON AIRCRAFT CABLE. **J. C. Cunningham, W. M. Davidson,** Westinghouse Electric and Manufacturing Company

44-200. PEAK VOLTAGES WITH D-C ARC INTERRUPTION FOR AIRCRAFT. **Virgel E. Phillips, Walter P. Mitchel,** formerly with General Electric Company

44-186. D-C ARC INTERRUPTION FOR AIRCRAFT. **J. S. Quill, L. T. Rader,** General Electric Company

CP.* PROBLEMS INVOLVED IN EXTENDING THE USE OF ELECTRIC POWER IN AIRCRAFT. **Mabel M. Rockwell,** Lockheed Aircraft Corporation

### 2:00 p.m. Aircraft Wiring

44-220. SOLDERLESS TERMINALS. **F. H. Wells,** Air-craft-Marine Products, Inc.; **J. C. Balsbaugh,** Massachusetts Institute of Technology

44-221. HISTORICAL DEVELOPMENT OF ELECTRIC CONNECTORS. **E. J. Neifing,** Cannon Electric Development Company

44-222. ELECTRIC CONNECTIONS ON AIRCRAFT. **L. A. Taylor, F. O. Stebbins,** General Electric Company

44-223. CABLE USED FOR TRANSMITTING ELECTRIC ENERGY IN AIRPLANES. **M. F. Peters, J. J. Phillips, Max Kronstein, Helen B. Jealous,** Titeflex Incorporated

44-224. REQUIREMENTS FOR LOW-VOLTAGE AIRCRAFT CABLE. **R. E. Hedges,** Douglas Aircraft Company, Inc.

### 2:00 p.m. Aircraft Motor Applications

44-207. ONE TYPE OF ROTARY MAGNETIC CLUTCH AND ITS ASSOCIATED BRAKE USED ON AIRCRAFT ELECTRIC MOTORS. **Leo Andrews, Fred Shanely,** Lear Avia, Inc.

44-188. CONSIDERATIONS IN SERVOMECHANISM DESIGN. **S. W. Herwald,** Westinghouse Electric and Manufacturing Company

44-198. SOME ASPECTS OF THE APPLICATION OF INDUCTION MOTORS TO AIRCRAFT. **H. J. Braun,** Westinghouse Electric and Manufacturing Company

44-195. ELECTRIC GUN TURRETS FOR AIRCRAFT. **J. D. Thompson,** General Electric Company

## Thursday, August 31

### 9:30 a.m. Power Transmission and Distribution

44-185-ACO.** THE INFLUENCE OF MUTUAL COUPLING OF TRANSMISSION CIRCUITS ON GROUND-CURRENT DISTRIBUTION. **M. J. Lantz,** Bonneville Power Administration

44-226. NEW 138-KV CABLE LINES IN LOS ANGELES. **C. G. Mansfield,** Bureau of Power and Light, City of Los Angeles

### 9:30 a.m. Aircraft Electrical Design

44-228. ALTITUDE RATING OF ELECTRIC APPARATUS. **Paul Lebenbaum, Jr.,** General Electric Company

44-229. PLASTICS IN AIRCRAFT ELECTRICITY. **E. B. Cooper,** E. I. du Pont de Nemours and Company

† Presentation and availability of these papers depends upon war conditions.

44-194. AIRCRAFT ELECTRICAL ACCESSORY VIBRATION INVESTIGATIONS. **D. R. Miller,** General Electric Company

44-227. AIRCRAFT ENGINE ACCESSORY VIBRATION. **J. Tyler,** Pratt and Whitney Aircraft

### 2:00 p.m. Aircraft Brush Wear

44-208. HIGH-ALTITUDE BRUSH PROBLEM. **D. Ramadanoff, S. W. Glass,** National Carbon Company, Inc.

44-230. THE TESTING OF BRUSHES FOR LIFE AND PERFORMANCE UNDER VARIOUS ALTITUDE CONDITIONS. **C. J. Herman,** General Electric Company

44-231. NEW TEST CHAMBERS FOR AIRCRAFT ELECTRIC APPARATUS WITH PARTICULAR REFERENCE TO CARBON BRUSHES. **E. R. Summers, J. F. Settle,** General Electric Company

### 2:00 p.m. Aircraft Lighting

44-206. THE DEVELOPMENT OF AIRCRAFT POSITION LIGHTS. **Jack Vitol,** Civil Aeronautics Administration, Department of Commerce

†. ULTRAVIOLET LIGHTING—BRITISH

44-233. AIRPLANE ENGINE AND PROPELLER TEST-CELL LIGHTING. **D. H. Tuck,** Holophane Company

### 2:00 p.m. Aircraft Power Systems

44-204. BASIC CONSIDERATIONS IN THE SELECTION OF GENERATORS AND BATTERIES FOR AIRCRAFT. **L. M. Cobb, H. M. Winters,** The Glenn L. Martin Company

44-199. PARALLELING AND REGULATION OF 24–28-VOLT D-C GENERATORS IN MULTIENGINE AIRCRAFT. **Arthur Siegal, D. G. DeCourcey,** Boeing Aircraft Company

44-202. CIRCUIT PROTECTIVE DEVICES IN AIRCRAFT. **Walter Kenworth, E. V. Sundt,** Littelfuse, Inc.

## Friday, September 1

### 9:30 a.m. Electronics

44-236. VACUUM-TUBE RADIO-FREQUENCY GENERATOR CHARACTERISTICS AND APPLICATION TO INDUCTION-HEATING PROBLEMS. **T. P. Kinn,** Westinghouse Electric and Manufacturing Company

CP.* ELECTRONIC FREQUENCY CHANGERS (Summary of papers presented at summer technical meeting in St. Louis, June 26–30, 1944). **F. W. Brucker,** General Electric Company

CP.* ELECTRONIC VOLTAGE REGULATORS FOR HIGH-VOLTAGE CIRCUITS. **W. H. Pickering, A. W. Schardt, S. C. Snowden,** California Institute of Technology

CP.* PHYSICAL ASPECTS OF ELECTROSHOCK AND ELECTRONARCOSIS. **M. S. Plesset,** California Institute of Technology

CP.* PHYSIOLOGICAL EFFECT OF ELECTRIC SHOCK. **C. F. Dalziel,** University of California

### 9:30 a.m. Industrial and Marine Applications

CP.* A SHIPYARD PUBLIC-ADDRESS SYSTEM. **W. Ross Aiken,** The Permanente Metals Corporation

CP.* ELECTRICAL PROPULSION OF SHIPS. **W. J. Prise,** Moore Drydock Company

*CP: Conference presentation; no advance copies of papers available; not intended for publication in *Transactions.*

CP.* ARC-FURNACE REGULATORS. **R. A. Geiselman, J. E. Reilly,** Westinghouse Electric and Manufacturing Company

### 9:30 a.m. High Voltages in Aircraft

44-203. A 120-VOLT D-C AIRCRAFT ELECTRIC SYSTEM. **L. M. Cobb,** Glenn L. Martin Company

44-237. IMPEDANCE of 400-CYCLE THREE-PHASE POWER CIRCUITS ON LARGE AIRCRAFT AND ITS APPLICATION TO FAULT-CURRENT CALCULATIONS. **Major C. K. Chappuis, L. M. Olmsted,** United States Army Air Forces

44-238. HIGHER-VOLTAGE D-C AIRCRAFT ELECTRIC SYSTEMS. **W. L. Berry, J. P. Dallas,** Hughes Aircraft Company

†. A-C SYSTEMS—BRITISH

### 2:00 p.m. Aircraft Automatic Control and Instruments

44-187. ELECTRICAL CONTROL IN AUTOMATIC PILOTS. **C. M. Young, E. E. Lynch, E. R. Boynton,** General Electric Company

44-239. APPLICATION OF ELECTRONICS TO AIRCRAFT FLIGHT CONTROL. **W. H. Gille, R. J. Kutzler,** Minneapolis-Honeywell Regulator Company

44-179. ELECTRIC AUTOMATIC PILOTS FOR AIRCRAFT. **P. Halpert, O. E. Esval,** Sperry Gyroscope Company, Inc.

44-193. INFLUENCE OF ELECTRICITY ON AIRCRAFT INSTRUMENTATION. **C. F. Savage,** General Electric Company

44-240. INSTRUMENTATION OF 400-CYCLE AIRCRAFT ELECTRIC SYSTEMS. **A. J. Corson, A. G. Stimson, W. A. Soley,** General Electric Company

44-181. THE GYROSYN COMPASS. **O. E. Esval,** Sperry Gyroscope Company, Inc.

### 2:00 p.m. Aircraft Power Equipment

44-84. BLAST-TUBE COOLING FOR AIRCRAFT GENERATORS. **C. G. Veinott,** Westinghouse Electric and Manufacturing Company

44-241. DESIGN CONSIDERATIONS FOR D-C AIRCRAFT GENERATORS. **J. D. Miner, Jr.,** Westinghouse Electric and Manufacturing Company

44-112. AIRCRAFT STORAGE-BATTERY DESIGN. **J. L. Rupp,** National Battery Company

44-184. CARBON-PILE VOLTAGE REGULATORS FOR AIRCRAFT. **W. G. Neild,** Bendix Aviation Corporation

44-190. A 40-KVA 400-CYCLE AIRCRAFT ALTERNATOR. **H. E. Keneipp, C. G. Veinott,** Westinghouse Electric and Manufacturing Company

### 2:00 p.m. Special Aircraft Equipment

44-182. SOLENOID-OPERATED HYDRAULIC VALVES FOR AIRCRAFT APPLICATIONS. **G. A. Goepfrich,** Bendix Aviation Corporation

44-242. SOLENOID-OPERATED CONTROL VALVES. **V. W. Eckel, O. H. Wisegarver,** Precision Products Corporation

44-183. ELECTRICALLY HEATED CLOTHING. **G. H. Wotring,** General Electric Company

**ACO: Advance copies only available; not intended for publication in *Transactions.*

## Co-ordination of Fundamental Electrical Graphical Symbols

Long-standing conflicts in electrical graphical symbols between the fields of electrical communications, power, control, and measurement have been settled under the pressure of war, which accelerated the overlapping of these fields and led to serious confusion in the industries affected.

The co-ordinated graphical symbols for capacitors, contacts, resistors, inductors, transformers, and operating coils are announced in American War Standard Z32.11-1944, "Co-ordination of Electrical Graphical Symbols," April 18, 1944, published by the American Standards Association, 29 West 39th Street, New York 18, N. Y., and priced at ten cents per copy.

*Electrical Engineering* will endeavor to conform to the approved symbols insofar as practicable. To expedite the application of the symbols, authors preparing manuscripts for submission to the Institute are urged to consult the Standards to assure conformity with approved practices.

## Board of Directors Report to be Published in 1944 Transactions

In accordance with last year's policy made because of governmental limitations on the use of paper, the annual report of the AIEE board of directors will not be published in *Electrical Engineering.* The report will be pub-

ished in the 1944 volume of AIEE *Transactions.*

Members who so desire may obtain copies of the report from AIEE headquarters, 33 West 39th Street, New York 18, N. Y.

# Aviation and Industrial Problems Top AIEE 1944 Summer Meeting Program

With 89 technical papers and some 30 conference papers presented and discussed in 21 technical sessions and 5 technical conferences, the Institute's 1944 summer technical meeting, held June 26–30, in St. Louis, Mo., set a new record in this respect. In spite of wartime transportation difficulties, attendance was almost up to the high level of the past four years, as indicated by the accompanying tabulations.

Sweltering heat, for which the Middle West long has been noted, greeted the early arrivals for the meeting and continued beyond midweek. Some of the meeting rooms in the Hotel Jefferson, meeting headquarters, were air-conditioned, but capacity crowds plus extreme heat somewhat overtaxed the cooling capacity so that the meeting was in reality a shirt-sleeve gathering. Comfortably air-conditioned sleeping rooms provided welcome relief after the hot days.

In subject matter, the emphasis of the technical papers was even more highly on war problems than at the previous technical meetings held since the United States was thrown into the conflict, even though previous meetings registered high levels of wartime flavor. Electrical applications to military aircraft topped the list with four sessions, and two sessions were devoted to industrial applications involving primarily wartime problems. As all approved technical papers, together with approved discussions thereon, eventually will appear in the 1944 AIEE *Transactions*, the sessions are not reported here. Available reports on technical conferences are presented in succeeding pages.

**Recent Summer-Meeting Registration**

| Year | Location | District | Registration |
|---|---|---|---|
| 1944 | St. Louis, Mo. | 7 | 1,142 |
| 1943 | Cleveland, Ohio | 2 | 1,179 |
| 1942 | Chicago, Ill. | 5 | 1,173 |
| 1941 | Toronto, Ont. | 10 | 1,204 |
| 1940 | Swampscott, Mass. | 1 | 1,010 |
| 1939 | San Francisco, Calif. | 8 | 945 |
| 1938 | Washington, D. C. | 2 | 827 |
| 1937 | Milwaukee, Wis. | 5 | 1,065 |
| 1936 | Pasadena, Calif. | 8 | 714 |
| 1935 | Ithaca, N. Y. | 1 | 901 |

On the program were the usual items of the annual business meeting and conferences of officers, delegates, and members, which included three parallel clinics on Section operation and management. Two medal presentations graced the annual-meeting program, the AIEE Lamme medal and the Faraday medal of the British Institution of Electrical Engineers; the latter marked the fourth award of that high honor to an American engineer. A general session at which three important anniversaries were celebrated and which included a feature address rounded out the program. Details of these and other features are given in succeeding pages.

A capacity crowd attended a luncheon meeting held Tuesday, June 27, jointly with the St. Louis Electrical Board of Trade. After the luncheon, Lieutenant Colonel T. B. Holliday (M '43) United States Army Air Forces, Wright Field, Ohio, and current chairman of the AIEE committee on air transportation, delivered an address "Aviation and the Electrical Engineer." The fact that modern airplanes can reach any part of the globe in 60 hours and therefore must operate in all climates presents a host of problems to aircraft designers, stated Colonel Holliday. He then proceeded to discuss some of the more important of these problems, with particular attention to problems associated with the electric systems. In no case, Colonel Holliday reported, has the electric system so far been shot out of any four-engine bomber that has "come home." J. W. McAfee, vice-president of the Electrical Board of Trade, presided.

Another special luncheon was staged on Wednesday, June 28, when the Circle Club of St. Louis, an organization of prominent engineers, entertained the officers, directors, and male headquarters representatives of the Institute.

As usual, many of the Institute's committees and subcommittees met during the meeting week, as well as the board of directors. In addition, the executive committee of the AIEE South West District met (the District in which St. Louis is situated), and a District student conference also was held.

The smooth functioning of all aspects of the 1944 summer meeting reflected the careful and painstaking advance planning that had been done by the meeting committee under the able chairmanship of B. D. Hull (F '39) South West Bell Telephone Company, St. Louis, who is a past AIEE vice-president and director. Other members of the committee and their specific assignments were as follows:

I. T. Monseth, *vice-chairman;* L. L. Crum, *secretary-treasurer;* F. A. Cooper, Jr., chairman. St. Louis Section; C. B. Fall, *finance;* C. H. Kraft, *meetings and papers;* B. T. McCormick, *registration and information;* R. G. Meyerand, *hotels;* E. S. Rehagen, *hospitality;* G. W. Thaxton, *transportation and trips;* L. F. Woolston, *publicity.*

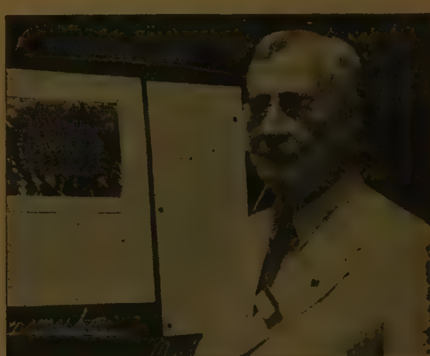
## Three Anniversaries Celebrated at St. Louis General Session

Brief historical addresses were delivered at the general session of the 1944 AIEE summer technical meeting, St. Louis, Mo., commemorating: (1) the 40th anniversary of the International Electrical Congress held in St. Louis in 1904; (2) the 60th anniversary of the AIEE; and (3) the 100th anniversary of the Morse telegraph. In addition, President Nevin E. Funk, who presided throughout the general session, also called attention to the fact that Charles F. Scott (HM '29) celebrates his 80th birthday this year. Doctor Scott served as the Institute's 15th president (1902–03) and has had a record of long and continuous service to AIEE; he was also vice-president of the 1904 Electrical Congress.

Following the celebration of these anniversaries, an address entitled "The Engineer's Present and Future Responsibilities," was delivered by Past President William McClellan, chairman of the board, Union Electric Company of Missouri, St. Louis, who also extended the official welcome at the opening session of the meeting. The essential substance of Doctor McClellan's address appears elsewhere in this issue.

### 40TH ANNIVERSARY OF INTERNATIONAL ELECTRICAL CONGRESS

Some of the significant events at the 1904 International Electrical Congress were outlined by A. S. Langsdorf (F '12), Washington University, St. Louis. This was the fifth in a series of World Congresses, the first of which was held in Paris in 1881 and the third at the Chicago World's Fair in 1893. Past



**H. H. Humphrey (A '96, F '13) consulting electrical and mechanical engineer, St. Louis, beside the meeting bulletin board which displayed a photograph in which he appears taken during the 1904 International Electrical Congress**

**Analysis of Registration at 1944 Summer Technical Meeting, St. Louis, Mo.**

| | Districts | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Classification | 1 | 2 | 3 | 4 | 5 | 6 | 7* | 8 | 9 | 10 | Foreign | Total |
| Members | 75 | 151 | 82 | 33 | 173 | 8 | 276 | 7 | 10 | 11 | 2 | 828 |
| Men guests | 7 | 24 | 6 | 3 | 20 | 3 | 68 | | | | | 131 |
| Women guests | 6 | 13 | 5 | 8 | 20 | 1 | 35 | | 3 | 2 | | 93 |
| Students | 2 | 6 | 3 | 3 | 21 | 1 | 51 | 3 | | | | 90 |
| Totals | 90 | 194 | 96 | 47 | 234 | 13 | 430 | 10 | 13 | 13 | 2 | 1,142 |

* District in which St. Louis is situated.

## Future AIEE Meetings

**Los Angeles Technical Meeting**
Los Angeles, Calif., August 29–September 1, 1944

**Winter Technical Meeting**
New York, N. Y., January 22–26, 1945

**North Eastern District Meeting**
Buffalo, N. Y., Spring 1945

**Summer Technical Meeting**
Detroit, Mich., June 25–29, 1945

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President Elihu Thomson headed the committee which organized the Congress and was elected its president at the opening meeting. Important papers were presented by electrical engineers and scientists of renown from several different countries.

One of the important developments of the 1904 Congress, Dean Langsdorf said, was the passing of resolutions that led in 1906 to the formation of the International Electrotechnical Commission; as a result, Congresses of the type held in 1904 have ceased to be held. At the close of that Congress, some of the delegates presented this resolution: "That America go forward, uplifting the banner of harmony and of liberty as it has done in the past, to the benefit not only of itself but of the nations of the whole world."

### AIEE 60TH ANNIVERSARY

"The Institute may have turned the corner from its lusty youth, but certainly there are no signs of waning vigor," declared Vice-President W. E. Wickenden in his remarks on the Institute's 60th anniversary. "The founding, 60 years ago, was an act of faith which has been richly and amply justified by works," he continued. "It was the prospect of the International Electrical Exhibition which was to be held in Philadelphia in the fall of 1884 under the sponsorship of the Franklin Institute . . . which gave occasion for the founding of AIEE."

Pointing out that the process of industrializing the United States in a big way began in about 1880, Doctor Wickenden said that engineers then were becoming conscious of one another and engineering was becoming conscious of an enlarging common destiny. These circumstances led to the founding of nine engineering organizations between 1880 and 1885, and of that group the AIEE is clearly most outstanding. From the prospectus issued before the first meeting, Doctor Wickenden read: "It is proposed to follow the model of existing engineering societies whose members assemble, read, and discuss papers and matters relating to their trades or professions, and at the same time enjoy personal and social intercourse, all of which is conducive to improvement and advancement in ideas, theories, practice, business and good fellowship," and the plan of organization included not only meetings, papers, and discussions, but also "a museum, a library, original research, protection from unfavorable legislation, and the settlement of disputed electrical questions."

"Rarely has any organization needed so little reorienting in its aim and its method as has the Institute during this 60 years," Doctor Wickenden continued. "Borrowing solidity of aim and organization from the senior societies of engineers, striking a prophetic note from the beginning, emphasizing fellowship, equally with research and invention as a fertilizing force, the AIEE was launched on a career which has been striking in its consistency, vigor, and fruitfulness. It has been and still is a young man's organization. It is an organization whose growth has overtopped that of its sister bodies.

"Today, it is probably the largest organization among the technological professions of the world, and it has given a leadership worthy of this youth and vigor. It has led and still leads in the fostering of international fellowship. It has led and still leads in standardization and was the first official group representing scientists, designers, manufacturers, and operators to codify experience and achieve mutual understanding for the advancement of the art.

"It has led and still leads in the decentralization of its activities. It led notably in the enlistment of students and in the fostering of education. It led through its unforgettable president, Charles F. Scott, in inducing Andrew Carnegie to provide a common home in New York for the engineering profession, thus setting in motion forces making for the solidarity of our profession which have yet to reach their full fruit.

"It has created a monumental literature. It has given stimulus to research of incalculable fruitfulness. It has engendered in the electrical industry a spirit of co-operation and emulation. You know that it is an extraordinary industry, a competitive industry, but one marked by striking spirit of mutual interest and of emulation. Each profits as all profit under the aegis of the Institute.

"From the beginning there has been no cleavage between the engineer as scientist, the engineer as inventer, the engineer as designer and builder, the engineer as operator, the engineer as administrator, and the engineer as public leader and benefactor. All have been comprehended within the Institute's large conception of the engineer and of his purpose in our society. To each of us the Institute has given a greatly enlarged opportunity for service and for recognition, and an added sense of personal and professional dignity, a heightened consciousness of obligations to our colleges and to society, an awareness of a mission which transcends the details of our daily jobs.

"It is therefore fitting that we should pause for a moment of homage to the founding fathers, men of faith, wrestlers with nature, searchers after scientific truths, organizers of experience, creators of industries, inspirers of youth, servants of mankind, and founders of a great tradition—a heritage we are proud to share and to which we dedicate ourselves anew."

### TELEGRAPH CENTENNIAL

The telegraph industry gave the initial impetus to all of the multiplicity of electrical industries as well as many affiliated industries declared F. E. d'Humy (F '30) Western Union Telegraph Company, New York, N. Y., in commenting on the 100th anniversary of the telegraph. We owe it to the persistence of Samuel F. B. Morse, artist turned inventer, that the electromagnetic telegraph was successfully demonstrated on May 24, 1844. "Mr. Morse was not only responsible for that great movement but through the efforts that were being made to push the telegraph industry into a real commercial activity, he was instrumental in bringing this society into being," Mr. d'Humy continued. "It was the getting together of 21 telegraph men, and four others, that really initiated the foundation of this great society of the AIEE," and its first two presidents were telegraph men. He also pointed out that Andrew Carnegie who donated the Engineering Societies Building in New York to the national engineering societies was a telegrapher in his younger days.

Referring to the 100th anniversary celebration of the transmission of the first telegraph message that was held in Washington, D. C., May 24, 1944, Mr. d'Humy explained that this was commemorated by reenactment of the actual transmission of that famed message, "What Hath God Wrought?" The message was transmitted from the same room in the Capitol to the same old railroad station of the Baltimore and Ohio Railroad in Baltimore, Md., and over the original instruments that Morse used 100 years ago. As so much had been written in newspapers and magazines throughout the United States on this celebration presenting many and varied views of this great happening, Mr. d'Humy said that there was really very little that he could add. He closed his remarks by inviting those present to attend a special technical session to be held in the afternoon of the same day at which three papers were presented reviewing progress in telegraphy during the hundred years following Morse's famed demonstration. These papers will be published in the 1944 AIEE *Transactions*.

# Two Medals Presented at 1944 AIEE Annual Meeting

Constituting the opening gathering of the 1944 summer technical meeting in St. Louis, Mo., the annual AIEE business meeting convened at 10 a.m. Monday, June 26. On the agenda were the usual annual items of Institute business, including the report of the board to the membership, the treasurer's report, tellers' report on election of officers for 1944–45, and report on award of prizes for 1943 papers. The program also included presentations of the AIEE Lamme medal and the Faraday medal of the British Institution of Electrical Engineers. The meeting was concluded with an address by President Nevin E. Funk, who presided.

Before the business of the morning got under way, Past President William McClellan, Union Electric Company of Missouri, St. Louis, extended the city's official welcome to those attending the summer meeting. Declaring that an annual Institute meeting had not been held in St. Louis since 1904, he called attention to

the tremendous changes that have taken place since that time. "I see a greater need than ever," he said, "for the AIEE annual meetings, these great get-together meetings, because the progress of events have so enlarged our fields of activity."

Speaking of the early days of the Institute, Doctor McClellan said that while the organizers were spurned as upstarts and given little credit, they did do one or two things that have been acknowledged. "We introduced accuracy; we introduced meters, and the whole field of engineering is using meters today; they never thought much of m tering until we came along. And then, our field is becoming more and more fundamental so that today electrical engineering and chemical engineering are two great divisions of engineering, frankly, upon which all others must depend more or less."

REPORT BY SECRETARY

"During the past year the Institute has continued co-operating in the war effort at every opportunity," said National Secretary H. H. Henline in presenting an abstract of the annual report of the board of directors. He reported that the Sections had set a new record in the number of meetings held during the fiscal year, totalling 743; of these 150 were technical-group, Subsection, or other types of special meetings. During the year, the last remaining part of the United States outside of Section territory was assigned to Sections, so that every member in the United States now is a member of some Section. He also called attention to the excellent work of the Student Branches which have been seriously handicapped, because so many of the students have gone into active military service.

A further increase in the total Institute membership was reported, the total at the end of the fiscal year being 21,407; since then the membership has increased still further and soon will be at the 22,000 mark.

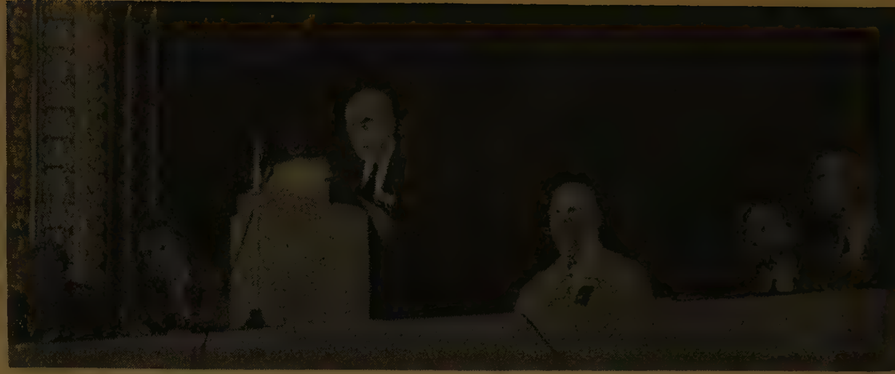
Because of the current critical shortage of paper, the board report will not be published in *Electrical Engineering* this year. Pamphlet copies are available at Institute headquarters to AIEE members on request.

REPORT OF THE TREASURER

In the absence of National Treasurer W. I. Slichter, National Secretary Henline also presented the treasurer's report for the year. The report showed that the Institute's income was the greatest on record and also that for the first time in years the market value of its investment is greater than the book value. A comparison of the current year with the preceding year is shown in an accompanying tabulation. As indicated in the table, the book value of all reserves was $315,225.29. Adding accrued interest, cash in reserve, and cash in general funds gives a total of $401,100.41, compared with $382,455.50 for the preceding year.

**The Institute's Financial Situation in 1943–44 as Compared with 1942–43**

| Item | 1943–44 | 1942–43 |
|---|---|---|
| Receipts for the year | $434,660.36 | $391,948.41 |
| Out-of-pocket expenditures | 331,344.39 | 354,377.70 |
| Allocated to pension fund | 85,000.00 | |
| Total expenditures | 416,344.00 | |
| Gain | 18,315.97 | 37,570.71 |
| Book value of all reserves | 315,225.29 | 278,398.33 |
| Market value of all reserves | 323,441.37 | 275,190.03 |
| Book value of all reserves | 315,225.29 | 278,398.33 |
| Accrued interest | 116.42 | 462.62 |
| Cash in reserves | 32,009.57 | 49,390.36 |
| Cash in general funds | 53,749.13 | 54,204.19 |
| Total assets | 401,100.41 | 382,455.50 |



**At the speakers' table during the annual meeting. Left to right: Irving Langmuir, General Electric Company, Schenectady, N. Y., Faraday medalist; A. P. M. Fleming (F '34) Metropolitan-Vickers Electrical Company, Ltd., Manchester, England, and local honorary secretary of AIEE for Great Britain, who presented the Faraday medal to Doctor Langmuir; A. H. Kehoe (F '25) Consolidated Edison Company of New York, N. Y., Lamme medalist; President Nevin E. Funk; President-Elect Charles A. Powel; National Secretary H. H. Henline**

REPORT ON ELECTION

The report of the committee of tellers was read by National Secretary Henline, and the nominees officially designated by the national nominating committee were declared elected to the various offices for their respective terms beginning August 1, 1944. The new officers were announced in the July issue (*page 268*).

Following the reading of this report, President Funk introduced President-Elect Charles A. Powel and performed the customary ceremony of pinning the president's badge to his lapel. Mr. Powel then spoke briefly, expressing his appreciation for the great honor the Institute had bestowed upon him. Commenting on the Institute's 60th anniversary, which was celebrated at the St. Louis meeting, Mr. Powel called attention to the solid record of achievement of those 60 years and envisioned the AIEE celebrating its 500th anniversary declaring that "there will be a steady advancement of the theory and practice of electrical engineering and of the allied arts for many centuries to come."

REPORT ON PRIZES FOR PAPERS

Prize winners for papers presented during the calendar year 1943 were announced by F. A. Cowan, chairman of the committee on award of national prizes. The prize-winning papers, together with certain District prize papers, were listed in the July issue (*page 268*). Among the various prize winners, only two were present to receive their awards: L. R. Ludwig (M '41) Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., coauthor of a paper with W. M. Leeds (M '38) of the same company; and B. R. Teare, Jr. (F '42), Carnegie Institute of Technology, Pittsburgh, coauthor of a paper with Mrs. Josephine R. Webb (A '41) formerly at that Institution, but now with the Westinghouse Company. A letter was read from the winner of the national Branch paper prize, R. W. Cronshey, formerly at the Michigan College of Mining and Technology, Houghton, who is now in military service overseas.

LAMME AND FARADAY MEDALS PRESENTED

In addition to the usual presentation of the AIEE Lamme medal, this year's meeting was honored with the presentation ceremonies for the Faraday medal of the Institution of Electrical Engineers, Great Britain. The former went to A. H. Kehoe (F '25), vice-president, Consolidated Edison Company of New York, N. Y., for "pioneer work in the development of a-c networks and associated apparatus for power distribution"; the latter to Irving Langmuir, associate director of research, General Electric Company, Schenectady, N. Y., for "his outstanding contributions to electrical science."

In describing the Lamme medal and the conditions under which it is awarded, S. B. Williams, chairman of the Lamme medal committee, pointed out that the medal is awarded annually by the AIEE for "meritorious achievement in the development of electrical apparatus or machinery." H. R. Searing (F '30) of the Consolidated Edison Company of New York, outlined the medalist's achievements, and in his response Doctor Kehoe narrated some of the events that took place during the development of successful multiple-feed a-c network distribution. The essential substance of the presentation addresses is scheduled for publication in a subsequent issue.

A. P. M. Fleming (F '34) of the Metropolitan-Vickers Electrical Company, Ltd., Manchester, England, presented the Faraday medal to Doctor Langmuir, on behalf of the Institution of Electrical Engineers, first briefly describing the conditions of award and mentioning some of the medalists' many contributions. He explained that the medal is awarded not more frequently than once a year for "conspicuous engineering or industrial achievement in electrical engineering, or for a notable service in connection with the development and advancement of electrical science in engineering." It is awarded without reference to nationality, place of residence, country of residence, or membership in the Institution. Three American

engineers have previously received the medal: Elihu Thomson in 1927; Frank B. Jewett in 1935; and W. D. Coolidge in 1939. The mutual dependence of England and America in the fields of science was emphasized by Doctor Langmuir in his response. He pleaded for a greater recognition of scientific endeavor by government and urged that incentives be provided to stimulate science and invention after the war. Essential substance of these presentation addresses also is scheduled for inclusion in a subsequent issue.

PRESIDENT'S ADDRESS

"This has been a very successful year," declared President Funk in his presidential address which brought the annual meeting to a close. "I don't take any credit for it at all," he continued; "the credit goes to all of those who arranged the programs or participated in them, and to the large number of members of the various committees that carried on their work so faithfully in spite of the great deal of personal hardship . . . on account of present-day difficulties."

Speaking of the Institute's meeting program during the year, Doctor Funk said there was quite a wide expression of opinion that it would not be patriotic to continue the meetings during the war. There is pretty definite proof that we were right in continuing these meetings, he asserted, because the attendance has been greater than before the war. Doctor Funk attributed the increased attendance partly to the fact that so many members were thrown into entirely different work from what they were accustomed to and that they therefore needed the new information they could obtain from the Institute's technical meetings.

Paying tribute to the work of the District organizations and the Sections, Doctor Funk expressed the opinion that we as an Institute have every reason to be proud of the work that the Sections are doing. He mentioned also the assistance that the District organizations have given the Sections in arranging for speakers and topics for Section meetings. He also expressed his gratification that many of the Sections are co-operating in local activities with other local engineering associations. He mentioned the war-production clinics that had been held in the various parts of the United States as outstanding examples of local co-operative projects.

Discussing student activities, President Funk urged that the programs of all national and District Institute meetings include a session for the students. Some of the boys put their elders to shame in presenting papers, he declared, adding that they also know how to handle questions during the subsequent discussion. He urged that the students also have a place on the social part of the program.

As a concluding thought, Doctor Funk emphasized the need for engineers to devote increased attention to human relationships, stating that when we "begin to deal with human relations, we are dealing with something that doesn't fit any type of mathematical formula," and pointing out that in some of these human relationships we must sacrifice efficiency to some extent if we are going to preserve freedom. "To overcome some of these difficulties," he concluded, "we must be prepared by a broader outlook, if we can, so that we do not hold too closely to our more technical performance, so we don't hold our technical performance so close to our eye that we lose the entire landscape of human needs and desires and hopes and all characteristics that make life worth living."

# Delegates' Conferences at St. Louis Feature Expanded Clinic Plan

Four sessions comprised the program of conferences for officers, delegates, and members at the AIEE 1944 summer technical meeting in St. Louis, Mo., which included one combined conference and three so-called Sections clinics. Initiated at the 1943 conferences, the success of the clinic plan led to its expansion to include three clinics this year as compared with the two held last year. Delegates from the larger Sections, the smaller Sections with concentrated membership, and the smaller Sections with scattered membership, respectively, discussed their Section operating and management problems in the three parallel clinics.

By grouping the representatives of Sections of similar type, Section operating problems common to each of the three classes of Sections could be discussed more advantageously than in one combined clinic. This year's clinics were outstanding for the number of delegates participating actively in the discussions. The plan used last year of having specific subjects introduced by "panel leaders" followed by scheduled and unscheduled delegate discussions from the floor was followed again this year.

At the combined conference, there were scheduled talks and some delegate discussion on a variety of Institute activities of interest to all Sections. A skit depicting in dramatic form some of the operating problems faced by many of the Institute's 73 Sections brought the combined conference to a close.

The success of this year's conferences amply justified the long hours of thoughtful advance planning on the part of the various members of the Sections committee and especially its energetic and capable chairman, G. W. Bower. Summarized reports of the proceedings at the four conferences follow.

## Combined Delegates' Conference

Scheduled talks on various phases of Institute activities, followed by informal discussion from the floor, comprised the major portion of the Tuesday afternoon combined conference of officers, delegates, and members. Section and District activities were covered by President Nevin E. Funk and National Secretary H. H. Henline, respectively. Chairman G. W. Bower reported on the activities of the Sections committee during the year, and chairmen T. F. Barton (finance), J. H. Pilkington (membership), and F. A. Cowan (prize awards) spoke on aspects of their respective committee activities that are of particular interest to the Sections. A plan of action whereby local engineering organizations may co-operate on projects of local interest was outlined by Everett S. Lee (F '30), chairman of the Engineers' Council for Professional Development. R. M. Pfalzgraff (M '41) of Wilmington, Del., vice-chairman of the Sections committee, presided throughout the combined conference.

Following the formal portion of the program, a skit entitled "The Rendezvous Arduous" was given, representing the executive committee of the AIEE "Utopia" Section in session. Problems faced by many of the executive groups of the Sections were portrayed in effective and sometimes amusing fashion. C. S. Schifreen, of the Philadelphia Section, acted as chairman of the Utopia Section. Other members of the "executive committee" were: F. J. Berger (A '27) vice-chairman (papers and meetings); A. C. Muir (M '39) secretary-treasurer; W. R. Clark (A '37) past chairman; W. F. Henn (A '41) (entertainment); L. E. Howard (A '40) (publicity); G. W. Bower (M '40) (membership); M. D. Hooven (M '30) (Subsection).

SECTION AND NATIONAL ACTIVITIES

Relationship between AIEE Section and national activities was the subject of the initial talk of the conference, given by President Funk. Declaring that "Section activity is really the lifeblood of the institution as a whole," he said that "as a national organization we really depend upon the Sections almost wholly to make the Institute a going aggressive organization."

Pointing out that the total attendance at local AIEE meetings far exceeds the total attendance at its national meetings, Doctor Funk declared that there is an even greater volume of information contained in the technical papers spread before the members at the local meetings than in the papers produced through the activities of the national committees. He also called attention to the splendid opportunities that the Sections have to co-operate with the Student Branches in their respective localities and at the same time bring the students in contact with men actively working in industry.

Emphasizing the importance of co-operation in the Sections, he said that "the only way a satisfactory conclusion of any effort is attained is by co-operative work," adding that "you cannot obtain the ability to co-operate by reading books. The only way you become proficient in that is by actually practicing it."

Referring specifically to the activities of the Sections during the war period, Doctor Funk pointed out that they have been more active than in previous years even though nearly everybody connected with the Sections has been busier than at any previous time. The work of the Sections has improved each year, he concluded, and "there isn't any question whatsoever that it is going to get better and better in the future."

PRESIDENT-ELECT POWEL SPEAKS

In his brief remarks, President-Elect Charles A. Powel emphasized the importance of co-operative work between the AIEE Sections and other local engineering organizations. Characterizing the American Engineering Council as a noble experiment that failed, he declared that "we just started at the wrong end. We were trying to get all of

he associations together at the top whereas ve should have been working down at the oundation." He expressed the opinion hat the Sections realize that co-operation vith other societies must be carried on locally.

DISTRICT ACTIVITIES

The District organizations fit in between he Sections and Branches and the national rganization of the Institute, pointed out National Secretary H. H. Henline in his alk on this subject. "Although District ctivities have been going on quietly and efectively for a good many years, perhaps that ery quietness and effectiveness have caused eople to overlook them," he continued.

Outlining the circumstances leading up to he establishment of the Districts, Mr. Henine told how a special committee recomnended in 1919 that there should be Disricts throughout the United States with a ice-president in each District. With the doption of this plan there began in 1920 the rocedure now followed in which the country is divided into nine districts with Canada omprising the tenth. A vice-president is lected in each District to be in charge of he activities in his District. These viceresidents are nominated entirely by the nembers of the executive committee in their espective Districts.

Initiation of the District plan started a hain of events that is still in progress, Mr. Henline continued, because occasionally we till have some further development conected with District activities. He related iow the board of directors authorized travelxpense allowances for the District execuive committees to meet in 1923, and for the vice-presidents to visit the Sections in their Districts in 1924. A little later, travel alowances were made for the vice-presidents o visit the Branches in their Districts. In 925 a plan was adopted for the holding of District meetings as distinct from both naional and Section meetings.

Travel allowances for District student conferences first were authorized in 1926. The success of the first conference led the board to authorize travel allowances for a tudent conference in each District each year.

The District activities are carried on by he District executive committee, Mr. Henine continued. This committee now conists of the District vice-president, District ecretary (appointed by the vice-president), he chairman and secretary of each Section n the District, the vice-chairman of the naional membership committee representing he District, and the chairman of the Disrict committee on student activities. Each District executive committee sets up a District co-ordinating committee, including ome of the members of the executive comnittee but making a smaller committee vhich is in a better position to take quick ction.

Reporting that a total of 49 District meetngs have been held, Mr. Henline stated that he District-meeting plan has been highly uccessful. It is intended that these meetings e of a rather local nature so that the memers in a District may concentrate on the subects in which they are especially interested. n addition, it has become customary to ive the students a prominent place in these District meetings, and that plan has been ighly successful.

The District organization and activities ave developed over a period of 24 years from actual experiences, Mr. Henline concluded. In many cases some experiment has been carried out successfully and then became part of the regular procedure. The District organizations have made it possible for members almost anywhere in the country to take a larger part in Institute affairs than they might otherwise and have contributed greatly to the development of the Institute.

**G. W. Bower (M '40) chairman of the AIEE Sections committee (left), and (right) C. S. Schifreen (M '43) chairman of the AIEE "Utopia" Section. A skit depicting a typical meeting of the Utopia Section executive committee was given at the close of the combined conference of officers, delegates, and members**

"WILL YOU HELP?"

In his talk, Mr. Lee first told how the Engineers' Council for Professional Development, joint agency of eight national engineering societies including AIEE, is endeavoring to enhance the professional status of the engineer, and second described a booklet entitled "Will You Help?" which outlines how the local organizations of these societies can co-operate to further this effort. Copies of the booklet were distributed to all those present.

Describing how the objectives of ECPD are carried forward by four standing committees —student selection and guidance, engineering schools, professional training, and professional recognition—Mr. Lee outlined some of the principal accomplishments of those committees. News reports of these activities have appeared from time to time in *Electrical Engineering* over the past several years.

Urging all of the delegates to take home and use their copies of the booklet "Will You Help?", he indicated how local action might be taken in the manner outlined in the booklet by local engineering groups leading to recommendations to the ECPD participating societies. These recommendations may then be passed upon by the societies, and in that way co-operative action may be taken on a national basis.

SECTIONS COMMITTEE ACTIVITIES

Promotion of the organization of Subsections and technical groups constituted one of the most important activities of the Sections committee during the past year, reported Chairman George W. Bower. Four new Subsections were formed, making a total of ten now in operation; 27 technical groups are now functioning, and several Sections were reported as considering the advisability of forming such groups. The project of organizing Sections in South America and in the West Indies, which was discussed at some length during the 1943 conference, has been held in abeyance because of the war.

"Subsection operation is gaining in popularity since the distribution of the folder 'Subsections' in March 1943," Mr. Bower stated. "The Sections committee is individually following 26 locations in the territory of the Sections where there are possibilities of successful Subsection operation. Many Sections have possible locations for Subsection operation, but in some cases the number of present Institute members at the location is too small for the organization of the Subsection. A survey of the territory may reveal many potential members, especially if local Subsection meetings are provided." He then cited the experience at Great Falls, Mont., where there were only five members. A survey revealed enough prospective members in that area to justify the formation of a Subsection, and the chairman of the Montana Section recently reported that in the near future there will be a very active Subsection at Great Falls. Mr. Bower urged other Sections to survey their territory for similar Subsection possibilities.

In order to assist in the further development of technical groups by the Sections, the Sections committee prepared a folder on that subject and circulated it early this year to all Section officers. In reporting on this activity, Mr. Bower emphasized the difference between the Subsections and the technical groups. The former provide for geographical diversification of Section activities, whereas the latter provide for diversification of technical subject matter discussed at meetings.

During the past year the Sections committee has endeavored to develop closer co-operation with the vice-presidents and chairmen of the national committees, Mr. Bower further reported. He urged that this effort be continued and suggested that the national technical committees could actively encourage the organization of technical groups in the various branches of electrical engineering through the co-operation of their committee memberships.

SECTION FINANCES

A brief outline of the Institute's general financial situation, with particular emphasis on Section finances, was prepared by Chairman T. F. Barton of the finance committee. As Mr. Barton was confined to his hotel room by a severe cold, his report was presented by W. R. Smith, Jr., member of the finance committee. The report centered around three charts showing the allocation of Institute receipts, expenditures, and investments, which were displayed prominently at the front of the room.

A chart on investments showed that the Institute now holds securities of the following classes:

| | |
|---|---|
| Government bonds | $200,000 |
| Public-utility bonds | 11,000 |
| Railroad bonds | 23,320 |
| Railroad preferred stocks | 14,100 |
| Common stocks | 70,500 |
| Gross total | $324,920 |

The chart depicting the sources of the Institute's revenue indicated the following:

| | *Per Cent of Total* |
|---|---|
| Membership dues | 67.1 |
| Advertising | 19.0 |
| Entrance and transfer fees and student enrollments | 7.3 |
| Miscellaneous | 4.3 |
| Investment returns | 2.3 |
| | 100.0 |

The Institute's expenditures were indicated on the third chart which showed:

| | *Per Cent of Total* |
|---|---|
| Publications | 28.2 |
| Headquarters expenses | 21.2 |
| Sections | 16.1 |
| Joint activities | 12.0 |
| Meetings | 6.0 |
| Committees | 4.3 |
| Student activities | 3.8 |
| Traveling expenses | 3.7 |
| Yearbook | 2.7 |
| District expenses and prizes | 2.0 |
| | 100.0 |

Mr. Smith explained that the Sections appropriation embraces a flat amount of $175 for each Section plus an allowance of one dollar for each active member in the Section territory on August 1 of each fiscal year. That item includes also: the cost of traveling expenses of Section delegates to summer technical meetings; stationery and supplies furnished by the headquarters office to the Sections; and a proportion of headquarters' salary expense chargeable to Sections. The item for meetings covers three national and two District technical meetings. Committee expenses comprise chiefly expenditures of the membership committee, technical committees, and the finance committee; Standards-committee expenditures are not included since this activity is substantially self-supporting. "Traveling expenses" include principally the traveling expenses of Institute officers including the board of directors, president, vice-presidents, national nominating committee, and Institute representatives. The last item listed includes traveling expenses for District executive committees plus the cost of District prizes awarded, in addition to the national prizes.

Following the presentation of this report there were several informal discussions from the floor. W. H. Taylor, chairman of the Denver Section, reported that 73 per cent of that Section's expenditures are for meeting notices and publicity; 12 per cent covers the meeting expense and 15 per cent "executive" expense. These proportions perhaps are typical of many Sections that print and circulate their own meeting notices. W. R. Hough of the Cleveland Section said that the Denver Section experience paralleled that of the Cleveland Section until about three years ago when the Cleveland Technical Societies Council was organized. That Council is made up of about 26 societies and it publishes a weekly bulletin which carries all meeting notices and is largely self-supporting through paid advertising. This has reduced the meeting-notice expense of the Cleveland Section to about 13 per cent of the total Section expenditures, leaving a larger proportion that can be devoted to meetings. P. L. Johnson, Los Angeles Section, related how that Section's expenses had been greatly increased in providing for the rapidly growing aircraft division of the Section. In the preceding two years, the increase in Section operating expenses was respectively $200 and $460, largely to provide for increased printing and mailing of meeting notices. These notices were sent to both new members and many prospective members chiefly in the aviation industry.

MEMBERSHIP ACTIVITIES

"The Section committees are the real backbone of the whole membership effort," stated J. H. Pilkington, chairman of the membership committee in speaking to the delegates on this subject. He outlined the organization and functioning of the national membership committee and the Sections membership committees, discussed some of the most important aids to membership work and some of the results achieved, and finally posed some of the problems that remain to be solved.

"Altogether it is estimated that over 1,000 men are engaged in Institute membership work," declared Mr. Pilkington, who explained that the national membership committee is composed of a chairman, a vice-chairman, a secretary, approximately ten members-at-large, ten District vice-chairmen, and the chairmen of the Section membership committees ex officio. The national committee serves as a clearing agency for all directives and is set up to aid the Section committees in many ways. The vice-chairmen direct operations in their respective Districts, but direct access to the national chairman by the Section membership chairmen is encouraged. "We view the work of the Section membership committees as not only that of obtaining new members but also that of holding existing members, especially those who may be wavering in their interest in the Institute," Mr. Pilkington stated.

"There are two kinds of aids which are and should be available for maximum effectiveness in Institute membership work. The first might be termed mechanical aids and the second psychological aids." Mr. Pilkington then described some of the mechanical aids available which include a membership committee guide, available from Institute headquarters upon request by the Section membership chairmen, and conveniently sized booklets prepared from time to time containing general information. The latest such booklet, entitled "Accomplishments of the AIEE in the Engineering World," was distributed to the entire membership in the fall of 1943. Additional copies are available from headquarters.

Among the so-called psychological aids, Mr. Pilkington mentioned as important our long record of technical accomplishments and the serious purpose back of them; good fellowship and sincere hospitality; and changes in organization setup to meet the changing demands and wishes of the membership. Among the little things that assist in this direction are the display of Member and Fellow diplomas by members in those categories and the simple expedient of inviting nonmember engineers to Institute meetings.

In regard to results, Mr. Pilkington stated that the net increase in Institute membership during the past two years totaled 2,500 or over 13 per cent, bringing the membership on April 30, 1944 to an all-time high of 21,407. This net increase came about from approximately 4,300 gross additions to the membership rolls. The 1,800 members who fell by the wayside include 1,200 dropped for nonpayment of dues. The latter, Mr. Pilkington declared, present a challenge that represents one of the problems to be solved. Another problem has to do with transfers to higher grades of membership. Although the Institute has a national transfers committee, the Section membership committees can assist in this effort.

Delegate discussions from the floor were given by Carl Evans, secretary of the Georgia Section, M. D. Hooven, New York Section, and R. C. Gorham, chairman of the Pittsburgh Section. A membership campaign carried on largely by mail which netted the Georgia Section an increase of 32 per cent in its membership in approximately two months was described by Mr. Evans. Qualified prospects were uncovered by member recommendations. These prospects then were written personal letters telling them they had been nominated for membership in the AIEE and that they had been investigated and found to be qualified, and enclosing a return postcard by which additional information could be obtained. Names of interested prospects were circulated in mimeographed form to the entire membership with the suggestion that if any member were personally acquainted with any of the prospective members and could serve as a reference that he get in touch with the prospective member and offer his services as a reference. This procedure is believed to have been an assistance.

Mr. Hooven told how the New York Section carries on its membership work with a committee comprising 130 members and auxiliary members totaling some 200 so that there are a total of between 300 and 400 members doing membership committee work in the New York Section. During the past year 430 new members were obtained, or a little over ten per cent increase in membership. Prospects are uncovered by letters to the entire membership, from cards signed by those attending Section meetings with spaces for notations by members and nonmembers, and through educational courses. Nonmembers are charged double the member fee to take educational courses operated by the Section, with the provision that those who join the Institute later will be refunded the additional charge. About 100 new members have been obtained through that channel. Prospects are followed up personally, either by letter, telephone, or personal call.

The Pittsburgh Section follows some of the same practices as the Georgia and New York Sections, reported Mr. Gorham. One source of new members that has been very fruitful in normal times, however, is providing almost no new members at the present, namely, the various engineering schools in that Section's territory. This partially accounts for the fact that the Pittsburgh Section registered only a five per cent increase in membership during the past year.

Closing the discussion of this topic, Mr. Pilkington presented membership increase statistics for the year as follows:

| | *Per Cent* |
|---|---|
| *Increase in total membership* | 13 |
| *Increases by Districts* | |
| Northwest (9) | 19 |
| Southwest (7) | 18 |
| Southern (4) | 18 |
| Pacific (8) | 15 |
| New York City (3) | 15 |
| Canada (10) | 13 |
| Great Lakes (5) | 13 |
| North Central (6) | 11 |
| Middle Eastern (2) | 10 |
| Northeastern (1) | 10 |

*Larger Sections equaling or bettering the national increase:*

| | |
|---|---|
| Milwaukee | 23 |
| Seattle | 21 |
| St. Louis | 20 |
| Los Angeles | 17 |
| Boston | 14 |

*Smaller Sections (scattered membership) that equaled or bettered the national increase:*

| | |
|---|---|
| Montana | 40 |
| East Tennessee | 39 |
| Arizona | 24 |
| Tulsa | 22 |
| Central Indiana | 20 |
| West Virginia | 16 |
| Urbana | 16 |
| New Mexico–West Texas | 15 |
| Alabama | 14 |
| Ithaca | 13 |
| North Carolina | 13 |

*Smaller Sections (concentrated membership) that equaled or bettered the national increase:*

| | |
|---|---|
| Mexico | 200 |
| San Diego | 34 |
| Montreal | 33 |
| Memphis | 30 |
| Georgia | 30 |
| South Bend | 28 |
| Houston | 26 |
| Wichita | 21 |
| Spokane | 20 |
| Dayton | 20 |
| Portland | 18 |
| Fort Wayne | 17 |
| Kansas City | 17 |
| Akron | 16 |
| Syracuse | 14 |
| Cincinnati | 14 |

### SECTION PAPERS AND PRIZE AWARDS

"A review of the prize-award practices to determine what if any changes in the setup appear desirable" has been in progress for some time, declared F. A. Cowan, chairman of the committee on prize awards, who added that one conclusion reached so far is that the Sections are quite an important factor in the prize-award setup. He explained that the Institute each year offers $1,500 in prizes, $500 of which goes for national prizes and the remainder allotted equally among the ten Districts. Experience in the past six years has shown that only about one third of the available $1,000 in District prizes has been used, whereas essentially all of the national prizes have been awarded. Many suggestions have been offered, Mr. Cowan said, as to how this situation should be remedied, and a poll of the vice-presidents' opinions seems to indicate that perhaps the Sections are not aware of the prize possibilities.

Pointing out that the officially approved technical papers on the programs of the national meetings automatically are entered in the national prize competition, Mr. Cowan explained that the Section papers also may compete, but in order to do so they must be entered specifically for that purpose. Likewise District-meeting papers are automatically considered for District prize awards, but the Section papers again must be submitted specifically in order to compete. He urged the Section delegates to take the necessary steps to enter Section papers in both the District and national competitions. A further advantage of submitting the papers would be that they would be reviewed with the idea of possible publication.

In regard to publication, F. A. Lewis, AIEE acting editor, reported that 12 Section papers had been published in the general-interest section of *Electrical Engineering* in 1943; in 1944 to date 8 Section papers have been accepted, three of which are still to be published. Considering that the Institute now has 73 Sections, and that only 7 Sections are represented among these papers published in 1943 and 1944 to date, Mr. Lewis expressed the opinion that there must be many Section papers that would make good material for publication in *Electrical Engineering* but that are not made available for that purpose. He urged the Section officers to submit their papers for publication, pointing out that by so doing they could serve a twofold purpose: (1) help to obtain more material for *Electrical Engineering*, thereby improving the over-all quality of the articles published therein; and (2) achieve recognition for their Sections through national publication of their papers.

The Philadelphia Section has a separate publicity committee which has as one of its duties arrangements for submitting to headquarters papers for publication in *Electrical Engineering*, reported A. C. Muir of that Section. When a paper has been presented before the Section and is considered to be exceptionally good, the publicity committee asks the speaker for copies to send to headquarters. If the paper is considered to be prize material, extra copies are submitted for that purpose. Mr. Muir reported that during the past two seasons, the Philadelphia Section had submitted to headquarters six papers, four of which had been accepted for publication, and efforts are being made to have two more prepared that were presented originally before technical-discussion groups.

## Larger-Sections Clinic

R. M. Pfalzgraff of the Philadelphia Section, vice-chairman of the Sections committee, presided, and W. F. Henn of the Philadelphia Section acted as secretary. The larger Sections clinic was supplemented by an advisory panel group which opened discussion on the various scheduled items. Members of this group were: R. V. Shepherd, Schenectady Section, who conducted the discussion on meetings and programs; R. G. Warner, Connecticut Section, AIEE director and chairman of the Student Branch committee, student activities; R. C. Gorham, chairman-elect and present secretary of the Pittsburgh Section, fellowship; W. R. Clark chairman of the technical groups committee of the Philadelphia Section, technical groups and Subsections.

### MEETINGS AND PROGRAMS

Mr. Shepherd said that the Schenectady Section, because of the large number of technical societies in its city, was faced with a problem of getting regular attendance at AIEE meetings. The Section had solved this problem by designating Thursday night as electrical-engineers' night, and the other groups had co-operated by not scheduling their programs on Thursdays. The Schenectady Section is a member of the Schenectady Engineering Council which co-ordinates the activities of its respective member societies in order to make all meetings of general interest available to the entire group. Each member group in the council is allotted one or two general-interest meeting nights and several other meeting nights to cover technical subjects in its own field. The Schenectady Section has continued co-operation with the Pittsfield Section through its joint prize paper contests for younger engineers.

J. W. Bishop, chairman of the Michigan Section, announced that his Section had sponsored five round-table discussions during the past year, two of the meetings being held in Jackson and arranged by the Jackson members of the round-table committee. The round-table meetings are concerned with solving local problems.

C. A. Smith reported that the San Francisco Section has instituted a special shipyard group. An average of 80 persons attends these meetings. Eighteen new AIEE members have been obtained through the shipyard group and the mailing list includes about 220 nonmembers. Subjects discussed at these meetings included arc welding, public-address system and gyroscope-compass pilot indicator, interior communications and marine cable in wartime, planning the world we want, marine electric equipment under the auspices of the Navy, and designing and operating ships' electric systems.

Printing and mailing costs for announcements of meetings and methods for financing these expenses were discussed.

### FELLOWSHIP

Mr. Gorham introduced the subject of fellowship and suggested the following topics for discussion: a fellowship committee, social periods, an attendance committee, identification cards, greeting letters, weekly get-acquainted luncheons, and student and member banquets.

W. R. Hough of the Cleveland Section reported that his Section had a reception committee and an attendance committee and had been successful with identification badges, social periods following the meetings, and its annual ladies' dinner. M. W. Pullen, chairman of the Maryland Section, stated that that Section had had unusually good attendance and attributed this in part to the dinners which preceded their general sessions.

W. F. Henn declared that the Philadelphia Section had dinners and social periods in connection with their meetings. This Section reported success with the use of identification tags which they placed in a grand-prize bowl for prize drawings at the end of the year.

M. D. Hooven, New York Section, cautioned against the danger of a Section's making its meetings overtechnical and not allowing time for a social period. The New York Section gained a lot of younger men who are interested in technical matters but lost older engineers because of inadequate fellowship activities.

### STUDENT ACTIVITIES

Mr. Warner urged that if Sections have committees to co-ordinate Branch interest, they should place on these committees the outstanding men in their Sections who will be an inspiration to the student members. He suggested Sections having annual dinners at which students are special guests and sit with men who are leaders in the particular fields in which the students are interested. He cautioned against a Section's dropping student activities because of a dearth of students resulting from the war and said that the student organization should be kept going. "When there are one or two students, those have to be the leavening for the one or two coming back from the service."

Nevin E. Funk, president AIEE, advocated the Section being the guests of the students. "It really makes them feel, since they are hosts, that they are part of the major organization," he pointed out. Section members interested in the student organization should

make sure that older members turn out in good enough force so that the students would not feel slighted, he cautioned.

TECHNICAL GROUPS AND SUBSECTIONS

Mr. Clark outlined the nature of technical groups and Subsections and the benefits the Section derives from them and told how they are organized. There are three types of discussion group meetings, he explained: short talks by one, two, or three individuals on the subject of discussion and general discussion following; panel discussions with experts in the field to answer questions from the audience, and the single formal talk followed by discussion from the floor. Chairman Pfalzgraff pointed out that the larger Sections incline toward subdivision into technical discussion groups, whereas the majority of Subsections are sponsored by the smaller Sections. As of June 26, 27 technical discussion groups were reported in operation in 13 Sections of the United States—eight of them large Sections; but of the ten Subsections functioning, only four derive from larger Sections. Subsection possibilities are being considered in the Michigan Section in Bay City which is 106 miles from headquarters and has a population of 48,000. San Francisco reports two Subsection possibilities one in Sacramento, 99 miles from Section headquarters with a population of 106,000 and 11 AIEE members; and Laro and Mare Island Navy Yard, 35 miles from Section headquarters with a population of 20,000 and over 34 AIEE members. Seattle Section has a possibility in Tacoma, Wash., 31 miles from headquarters with a population of 109,000 and 31 AIEE members.

P. L. Johnson, Los Angeles Section, described the formation of the aircraft and electronics divisions in his Section. Because of the widespread aircraft industry in their area, the aircraft engineers were considering the formation of a separate technical society. In the interests of unity, the AIEE Section persuaded the aircraft people to make use of the already established AIEE organization for promoting their technical meetings. A recognized leader for the group was appointed by the Section executive committee, and four meetings were conducted in 1942–43. During the 1943–44 season the aircraft group held five meetings with an average attendance of 208. The increase in national membership in the Los Angeles Section in the last two years was 84. At the Los Angeles technical meeting, August 29–September 1, of the 16 technical sessions 13 will be devoted to aircraft problems, and more than 50 technical papers on this subject will be presented.

Mr. Hooven said that the New York Section, faced with the problem of serving a large concentrated membership in a restricted area, has become a sort of holding company for five major technical groups, some of which were established as early as the late '20's. Each group holds individual meetings, chooses its own officers and committees, and shares the same membership of 4,000. Each group meets jointly with other organizations of similar interests such as the Institute of Radio Engineers, American Society of Mechanical Engineers, and Illuminating Engineering Society. The New Jersey members, opposed to forming a Subsection, are represented by a special-activities committee which functions autonomously. The year's program for the New York Section includes 20 Section meetings, about 100 lecture meetings as part of educational courses, and many committee meetings. The technical groups have become operating "Sections" in the New York area.

C. H. Cutter of the Seattle Section reported that Tacoma which had been mentioned as a possible location for a Subsection preferred to remain in the Seattle Section; one Section meeting was sponsored by the Tacoma group each year. He also stated that Seattle Section had considered forming an aircraft group for the Boeing Company electrical engineers, but the Boeing Company group preferred to have their own meetings and remain part of the general Section; one Section meeting is turned over to the Boeing group also each year.

F. C. Barnes, chairman of the Toronto Section, announced that the Hamilton discussion group had blossomed into a Subsection last spring and has 55 members. The Ottawa Subsection has 38 members, and the Frontier group has formed a Subsection which has been in operation for one year. Toronto also has another group of 38 members 90 miles from Section headquarters which is expected to develop into a Subsection very soon. Mr Clark described the formation of the Wilmington Subsection of the Philadelphia Section. Mr. Smith stated that San Francisco is considering the possibilities of a Sacramento Subsection, but certain problems must be solved first. A common problem of both Section and Subsection activity is that of financial support; publicity accounts for the largest expenditure in almost every instance and is the most important factor in promoting successful meetings.

AFFILIATED SOCIETIES AND CIVIC AFFAIRS

C. M. Lovell, St. Louis Section, described the activities of the joint council of the Associated Engineering Societies of St. Louis, formed in 1914 and consisting of three representatives each of the Engineers' Club of St. Louis, the local sections of the various national engineering societies, and the American Welding Society. The Council promotes participation in civic affairs and has worked on the municipal smoke-abatement campaign and the registration of professional engineers in Missouri. Currently, a committee of the council is meeting with the Chamber of Commerce and other civic organizations to consider postwar problems and planning. The council is financed by an annual assessment not to exceed ten cents per member for the membership of the societies.

Mr. Hooven, representing the AIEE subcommittee on civic affairs, declared that one of this committee's aims is the espousal of local engineering councils interested in effecting greater public welfare and the promotion of national and sectional programs in the public service. W. R. Hough of the Cleveland Section described the Cleveland Technical Societies Council which has its headquarters in the building owned by the Cleveland Engineering Society; provides a permanent meeting place for each of the affiliated societies; and issues a weekly self-supporting bulletin to handle publicity stories, notices of meetings, and items of mutual interest.

In the Milwaukee Section, according to Ralph H. Earle, chairman, participation in civic affairs is supervised by the Engineering Council through a civic-affairs committee. Public-service projects such as studies of the erosion of the shores of Lake Michigan are conducted by means of inspection trips and reports of the observation.

## Smaller-Sections Clinic—Concentrated Membership

G. W. Bower of the Philadelphia Section, chairman of the Sections committee, presided at the smaller Sections clinic, concentrated membership, and C. S. Schifreen of the Philadelphia Section acted as secretary. Members of the advisory panel group for this clinic were: E. T. Mahood of the Kansas City Section, AIEE vice-president, District 7, member and last year's chairman of the Sections committee; Walter Criley, Rochester Section; Everett S. Lee of the Schenectady Section, member of the Student Branch committee and chairman of the Engineers' Council for Professional Development; P. L. Alger, Schenectady Section, chairman of the subcommittee on engineers' participation in civic affairs.

MEETINGS AND PROGRAMS

Mr. Mahood introduced the subject of meetings and programs and outlined the various points to be discussed under this heading. He stressed the importance of a Section developing programs particularly appropriate for their own members in their own part of the country, the desirability of planning ahead for a year's program, the proper timing of meetings, and the importance of a meeting starting on time.

C. P. Robinson, speaking for the Mansfield Section, said that his Section had an unusual situation in that 33 of its 80 members were located in Galion, 17 miles away, and all were identified with the same company, a telephone manufacturing company. The Section program is set up on the basis that two of the six officers are selected from the members in this company each year, and two of the four technical sessions in a year are held at Galion and directed toward the interests of the telephone men.

F. L. Lawton said that the new Montreal Section, in order to attract both the older and younger members, had held a daytime annual meeting which started at three o'clock in the afternoon at a country club and included golf, dinner, business meeting, entertainment for the ladies, and movies.

V. F. P. Sepavich said that the Worcester Section had had to make its meetings appeal to the members from a social standpoint and had also selected subjects of popular wartime interest to attract a large attendance.

T. E. Rodhouse reported that the Pittsfield Section had about 250 national members and 1,500 local members, as a result of the popular general-interest lecture service which the AIEE Section conducts there. This Section also conducts a series of technical lectures. President Funk praised the experiment of the Pittsfield Section and said that smaller communities presented a good opportunity for an AIEE Section to make itself a going and active concern in the community in this fashion. Mr. Mahood suggested local membership as a possible means of a Section's retaining the interest of younger AIEE members who drop out because for a time they cannot afford to continue their national membership. C. W. Lethert, Minnesota Section, said that his Section had discovered it had a fertile

field for local membership, and that as a result of this its local membership had jumped from 12 to 67 this year. Mr. Criley stated that the Rochester Section had set up its own rules for local membership, that an applicant must have 600 hours of electrical education beyond high-school level or must have a minimum of five years experience in electrical work—maintenance or construction—and must be a foreman, subforeman, or group leader. Local members are allowed to serve on committees, but they cannot vote nor hold office.

FELLOWSHIP

Mr. Criley introduced the subject of fellowship and said that the Rochester Section had built its fellowship around stag parties and bowling, preceding a technical session had dinner for the speaker to which anyone might come, sent new members letters of welcome, and held weekly luncheons one month in the year in co-operation with the Rochester Engineering Society.

J. W. Gehrke, secretary of the Dayton Section, reported that his group, a new Section, had had unusually good success with celluloid name buttons at their meetings. J. R. Morton, Memphis Section, declared that his Section uses attendance buttons and awards attendance prizes from a drawing. The winner of an attendance prize must identify by name everyone at his table before receiving the prize.

B. H. Bell stated that the New Orleans Section believed that if you give a member a job to do he is always a better member. Therefore, all of their committees are large, and the committee chairman turns over at least one meeting to each committee member. This year each meeting will be in charge of two members of the program committee, one experienced member and one younger student member; the student member will be responsible for the meeting and will be advised by the experienced member. The New Orleans Section also has a prompt-attendance prize, and all members and guests who are present before the meeting starts participate in the drawing. W. T. Johnson, chairman of the San Diego Section, said that his Section succeeded in keeping up the attendance of its older members by awarding past presidents gold buttons to wear at meetings instead of the celluloid button worn by other members.

President-Elect C. A. Powel pointed out that the Institute is really conducted in the Districts and the Sections. "This trend toward decentralization is worth while," he declared, "and should be pushed. When the Institute reaches a membership such as ours has of nearly 22,000, we at the top of the association cannot hope to continue to direct it entirely from the top. The men that have to run the Institute are you fellows that are running the Sections."

STUDENT ACTIVITIES

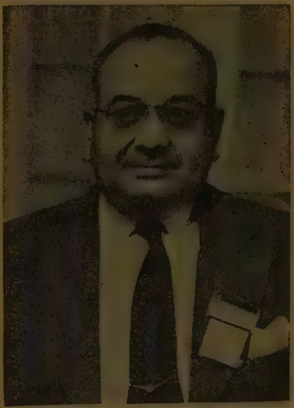
Chairman Bower, introducing Mr. Lee who led the discussion on student activities, said that only 20 per cent of the AIEE Sections have student-activities committees or committees of similar nature. Mr. Lee urged the necessity of Sections co-operating in student activities even though they are located where there are no Student Branches. When students are graduated, he pointed out, they move to other localities where there are industries but possibly no Student Branches, and it is up to the Sections of the students' new localities to contact them and keep in touch with them until they become Associate members. Mr. Mahood stated that in the South West District there are 14 Student Branches, one or more in every section of the territory with the exception of Wichita and that those Sections are very close to the Student Branches.

C. P. Knost, chairman of the New Orleans Section, said that his Section has co-operated with the Louisiana Engineering Society which takes in all four Founder Societies and some other engineers in creating a committee on student guidance. This committee has fostered talks by engineers to the high-school boys about engineering and appoints counselors for them. A. J. Allen said that the Cincinnati Section holds its meetings at the University of Cincinnati when the subject is of particular interest to students. At the June meeting three prizes are awarded to electrical-engineering students by the Section for work on their final theses.

W. E. Enns, secretary of the Portland Section, said that his Section entertained the students at a dinner meeting in the fall, and the students in turn entertained the Section at the closing meeting in May. The Portland Section offers a prize of one year's Associate membership for the writer of the best student paper. They have sponsored a Dutch Uncle scheme whereby a student interested in a particular phase of electrical work is given an engineer experienced in that line as a personal adviser. E. F. Lopez stated that the Mexico Section, faced with the problem of engineering students who did not speak English, had published a bulletin in Spanish which included two or three articles from *Electrical Engineering* translated into Spanish.

TECHNICAL GROUPS AND SUBSECTIONS

Introducing the subject of technical groups and Subsections, chairman Bower stated that there are at present 26 technical groups in operation throughout the country covering 11 subjects, and a large increase in number of groups is expected next year. Mr. Gehrke described a new technical group in the Dayton Section on electrical engineering and aeronautics which started in November 1943. The group has had four meetings, each one consisting generally of two half-hour papers and ten minutes of discussion. The meetings are attended by about 100 persons each.



**E. F. Lopez (M '18), Mexico Section, was the delegate who traveled farthest to the summer meeting. A familiar figure at summer meetings, Mr. Lopez reported that the Mexico Section had trebled its membership during the past year and that during the coming year it expected to double its present membership**

Mr. Lethert reported that the Minnesota Section has one technical group on power which has been in existence about five years and is planning to establish a communications group in connection with the Northwest Bell Telephone Company where the Institute has at present only one national member. Mr. Enns announced that the Portland Section has had three technical groups for a number of years: transmission and distribution, communications, and an electrometallurgical and electrochemical group. This year the three groups have collaborated on inspection trips of shipyards, aluminum plants, and steel mills.

Mr. Criley stated that there are too many technical meetings in Rochester, and therefore the Rochester Section's two technical groups on power and communications which have been in existence about ten years have to compete with a great many other technical meetings. He cautioned that a technical group meeting should consist of a number of short prepared discussions rather than one long speech. Mr. Lawton, Montreal Section, described the formation of the new Ottawa Subsection which has held two meetings, one in March and one in April, with an average attendance of 40 persons.

Hezzie Clark, secretary of the Houston Section, and J. D. Mathis, chairman of the New Beaumont Subsection, described the formation of the new Subsection. Mr. Mathis said that a faction of the Subsection wished to take steps to form a new Section, and suggested the possibility of the Lake Charles area joining with them in this endeavor. The Lake Charles area is now in the New Orleans Section, although 250 miles from New Orleans but only 45 to 50 miles from the Beaumont Subsection. Chairman Bower cautioned against formation of Sections with too small a membership to carry on Section work effectively. He said that there are ten Subsections operating in the AIEE at present, four of which were started this year, and there are 26 locations where the operation of Subsections is being considered.

AFFILIATED SOCIETIES AND CIVIC AFFAIRS

Mr. Alger urged formation of affiliated societies' councils to promote engineers' participation in civic affairs. He cited the directory of the Technical and Scientific Society Council of Cincinnati, which lists all the engineers in the community with their job titles and addresses as a successful joint enterprise.

## Smaller-Sections Clinic—Scattered Membership

A. C. Muir, Philadelphia Section, secretary of the Sections committee, presided at the smaller Sections clinic scattered membership, and L. E. Howard of the Philadelphia Section acted as secretary. Advisory panel members were: G. R. Peirce, chairman of the Urbana Section, meetings and programs; V. P. Hessler, chairman of the Kansas City Section, fellowship, entertainment, and attendance; M. S. Coover, Iowa Section, AIEE director and member of the Sections committee, student activities; E. W. Schilling,

Montana Section, AIEE vice-president, District 9, and member of the Sections committee, technical groups and Subsections.

MEETINGS AND PROGRAMS

H. E. Pearson, chairman of the Lehigh Valley Section, described the manner in which meetings were handled in his Section which has an extensive area and scattered membership. The Lehigh Valley Section is divided into eight districts with a manager over each district. One meeting per year is held in each district, alternating between the four northern and the four southern towns. The managers of all districts are members of the meetings and papers committee. The chairman of this committee co-ordinates all papers and programs for the year.

H. A. Norburg, Tulsa Section, said that the membership of his Section is culled from a radius of 260 to 300 miles. No group is large enough to have a separate meeting, and so the Section tries to have one program of particular appeal to each group during the year. The average attendance per meeting is about 40 out of 90 members. The Eastern Tennessee Section reported that it has co-operated with the American Society of Mechanical Engineers in getting speakers, and thus had been able to get good speakers of national importance.

FELLOWSHIP

Professor Hessler, introducing the subject of fellowship described the machinery for getting acquainted which had been in operation in the Kansas City Section for the past six years. The Sections' popular dinner meetings draw an average attendance of 60 members from a membership of 150. Members of the American Society of Mechanical Engineers, the American Society of Civil Engineers, and other associations also are invited, and a more widespread interchange of ideas is effected. Fellowship among the members is strengthened by an annual spring social meeting to which wives and sweethearts of the members are invited.

Otto Meier, Jr. said that the North Carolina Section has only two meetings a year, but they are really one-day conventions. The Section covers a large area; members are scattered over the entire state, and they have to travel as far as 300 miles to attend meetings. They come in automobiles, several traveling together. C. R. Smith stated that the Arizona Section had the same geographic problems as Professor Meier's Section. They hold one meeting each month from September through May. A free dinner is given to the member who travels the greatest distance, but each member can have only one free dinner in a year. The Section has 48 national members and 45 local members.

Discussing the subject of local membership, A. F. Hartung, Kansas City Section, said that the Kansas City Section formerly had had a trial local membership with three dollars annual dues to try to interest candidates in joining the national organization. This local membership was limited to a two-year period per member. He stated that this experiment resulted in the increase in Section funds and some increase in national membership.

C. P. Allen said that his Section had joint boatrides, inspection trips, and meetings with mechanical and chemical engineers which contributed fellowship and interest in Section activities. Professor Hessler and G. B. Smedley, Chicago Section, mentioned the hobby night which the Illinois Subsection had for one of its social meetings, and said that it worked out successfully.

STUDENT ACTIVITIES

D. R. Hoopes said that the Utah Section urged its members each to sponsor a student and act as an adviser to him. A member from the Iowa Section stated that his section had gotten out a pamphlet on AIEE which is being distributed to students in high schools.

Professor Meier stated that the North Carolina Section's one-day meetings are attended by students, and they have a great deal to do in evolving the program. Students attend from Raleigh and Durham, and a prize of a year's membership and a complimentary dinner is given to the senior student presenting the best paper.

Mr. Hoopes said that his Section is a smaller one and has many social affairs which promote fellowship. The juniors and seniors of the University of Utah are student members of this Section and usually attend the social meetings 100 per cent.

A. B. Credle, chairman of the Ithaca Section, said that because of the year-round Naval training school now in existence at Cornell University, his Section had expanded its 9-month schedule to a 12-month one during the past year. The Section has about 200 members, 60 of them from the Naval training school at Cornell. The Section does not attempt to register students until they are in their junior year.

TECHNICAL GROUPS AND SUBSECTIONS

Professor Schilling, introducing the subject of Subsections and technical discussion groups, said that the Montana Section was starting a Subsection in Great Falls. There are two Institute members there, and the Section has contacted the electrical engineers of the Anaconda Copper Mines with the result that 15 applications for membership have been received. Engineers of other companies will be asked to join later. Professor Coover announced that the Zanesville Subsection of the Columbus Section had been quite successful in attendance, although many of its members have to travel 50 or 60 miles to meetings.

Professor Peirce said that his Section had had considerable success with its Illinois Valley Subsection which centers around Peoria. There are about 12 new members, and the Subsection has increased the national membership by about 27 or 28. Mr. Smedley said that the reason the Illinois Valley Subsection has doubled its national membership is that there is a very large local membership who are provided with speakers and kept informed of national activities at the nominal fee of one dollar a year membership.

E. H. Flath, secretary of the North Texas Section, stated that that Section, which covers 150 to 200 miles north and south and 700 to 800 miles east and west, would like to know how to go about organizing a Subsection. This Section has about 100 members in Dallas and 150 in Fort Worth and has a six-month meeting schedule but has received no requests for organizing a Subsection.

AFFILIATED SOCIETIES AND CIVIC AFFAIRS

Chairman Muir stated that of the 73 Sections in the Institute, 58 per cent are members of engineering councils. He pointed out the advantages of affiliated societies: use of the same dining room, employment of same secretary, joint bulletin, and reduced cost of circulation.

**President Nevin E. Funk pinned the President's badge on President-Elect Charles A. Powel's lapel during the annual meeting. Here they chatted with two other members. Left to right: Mr. Powel; C. E. Stephens (M '22) Westinghouse Electric and Manufacturing Company, New York, N. Y., and past director; Doctor Funk; H. C. Forbes (M '30) Consolidated Edison Company of New York, N. Y.**

## Conference on Educational Problems and Student Counseling

More than 115 college teachers and engineers from industry who were interested in engineering education attended the conference on problems in engineering colleges and their effects in industry. The conference paper "Postwar Courses and Curricula in Electrical Engineering" was presented by the author, Professor R. G. Kloeffler (F '32) of Kansas State College. The paper, first of its kind to be presented before the AIEE, outlined the instrumentation by which the many phases of postwar educational planning for electrical courses could be effected. The analysis of the subject was well received, and the tenor of the discussion indicated that several engineering colleges were planning postwar training surprisingly close to the lines of thought expressed by the author.

An informal talk on "Interpretation of Present Hiatus in Engineering Education on Postwar Demands for Engineers" was given by J. L. Hamilton (F '21), Century Electric Company, St. Louis, who deplored the present condition whereby engineering education is practically deleted from the colleges, thereby leaving a dearth of incoming capable talent for the future services of industry. By calculations which involved figures based upon the war debt and the earning capacity of the nation, he arrived at 20,000 engineering graduates per year as the conservative number of engineering students which would be demanded from the colleges in the years directly following the cessation of hostilities, a number that is nearly double that of years preceding the outbreak of the war. To graduate this number of engineering students, he explained, would tax the teaching facilities of the colleges, and he proposed that industry itself should take an active part by co-operating with the colleges in the training of these engineers, and thus relieve to at least some degree the burden on the college faculties. The conclusions and recommendations of the speaker were supported in the ensuing discussion both by engineering teachers and by the industrialists. It was generally commented after the meeting that never had such support been expressed in the belief that industries, both small and large, should participate actively with the engineering colleges in providing for the students the best possible means of developing their talents to the highest attainable degree.

Following the conference, a clinic was held on college and high-school student counseling. A recommendation was made by G. W. Bower (M '40) chairman of the Sections committee, that each Section form a student-activities committee, such a committee to be composed of professors and members of industry and to include, if possible, graduates of colleges in the community. This committee would supply counselors for the high schools and the colleges, attend Branch meetings, and promote membership after the student finishes college.

The work of the educational committee of the St. Louis Section was outlined by T. L. Jones (A '41), and S. P. Shackleton (M '23) chairman of the student guidance committee of the New York Section, covered the activities in the metropolitan New York area working as a part of the New York engineers committee on student guidance. This joint committee of the Founder Societies has been developing since 1937. He recommended that student contacts be made early in the high-school-student's course so that he will be prepared adequately for entrance into an engineering college.

R. C. Gorham (M '31) secretary-treasurer of the Pittsburgh Section, discussed co-operation of Sections with Branches. Suggested ways and means consist of the promotion of prize paper and speaking contests, assistance in planning Branch meetings, sponsoring regional meetings at which the students assume a part, and the promotion of a social event as a means of introducing the students to practicing engineers.

L. M. Robertson (M '38) outlined work done by a committee as a member of the Denver (Colo.) Engineering Council. During the past year a "career night" was held at which students down to seniors in the junior high school were included. Members of the public school system have been enthusiastic over the results in the added incentive and enthusiasm that students receive.

General discussion emphasized that the counseling program does not have for its goal the recruiting of students for engineering but rather the providing of advice and information so that only those students who are particularly adapted will enter on an engineering career. The choice must be the student's, and all that these subcommittees can or ought to do is to present to the students what engineering consists of and to help them to make their decision by being available and ready to answer their questions.

Material for this report was supplied by Robin Beach (F '35) chairman of the AIEE committee on education, and S. L. Henderson (M '34), chairman of the subcommittee on high-school-student guidance, who presided over the conference and the clinic, respectively.

## Conference on Experiences With Electric House Heating

A conference on experiences with electric house heating was held during the recent AIEE summer technical meeting in St. Louis, Mo., under the chairmanship of W. F. Ogden (M '41), chairman of the AIEE committee on domestic and commercial applications.

B. H. Martin of the Tennessee Valley Authority, Chattanooga, presented a paper "Electrical Heating of Small Homes in the Tennessee Valley" in which experience with electric house heating over a period of several years was reviewed. The application of electric heating in the area concerned has been almost wholly confined to what might be termed small homes. The average power consumption for 30 houses was shown to be 1.35 kilowatt-hours per cubic foot per season at a cost of 7.4 mills per cubic foot, on the standard TVA residential rate. It was emphasized that the cost of electric heat should not be compared with heating by other means on a "cost of fuel" basis alone, since electric heating increases usable space, effects savings in cleaning and redecorating, and is praised highly by those who use it. Usual installations in this area employ individual room heaters of the radiant-convection type, automatically controlled by thermostats built into each unit. This method of control improves the diversity of the load.

Following the presentation of Mr. Martin's paper, R. D. Sloan (M '28) presented comments on domestic electric heating at Grand Coulee Dam by Homer J. Dana of the State College of Washington, Pullman. It was recalled that during the building of Grand Coulee Dam many workers lived in electrically heated homes in Mason City, which was used by the State College of Washington as a laboratory to obtain unique data pertaining to average family requirements. When all factors which enter into a comparison between electric heat and other types of heating are taken into account, it was estimated that electricity at a rate of 6.3 mills per kilowatt-hour would compete evenly with 13,000 Btu coal at $8.50 per ton.

Experience with a heat-pump heating system was described in a paper "Reverse Refrigeration Applied to a New Haven Office Building" by E. Haviland Walton and Charles A. Williams (M '40), United Illuminating Company, New Haven, Conn. During the winter heat is extracted from water obtained from wells under the building and transferred to a water-circulating system. In the summer, heat is extracted from the water in the circulating system and removed by water obtained from the wells, to provide summer air conditioning. In this case the heat-pump system is feasible because of three factors:

1. Both heating and air conditioning are provided.
2. An adequate water supply is available from shallow wells.
3. Low-cost electric power is available.

It was shown that comparative annual fuel costs, with electricity at one-cent per kilowatt-hour, are:

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|---|---|
| Electricity using heat-pump system | $3.950 |
| Anthracite coal | 2,410 |
| Bituminous coal | 1,790 |
| Number 6 fuel oil | 1,660 |

Electricity also should be credited with the following intangible benefits:

1. Absolute cleanliness.
2. No fuel storage space required.
3. No chimney necessary.
4. Reliable supply of fuel.
5. Excellent year-round working conditions for operators.
6. Maintenance cost probably lower than for a fuel-burning system.

In subsequent discussion it was explained that the heating load was about twice the cooling load.

Material for this report was supplied by M. K. Brody (M '42) secretary of the committee on domestic and commercial applications, who acted as secretary of the conference.

## Open Meeting on Domestic and Commercial Applications

An open meeting of the committee on domestic and commercial applications was held during the recent AIEE summer technical meeting in St. Louis, Mo., at which three reports of subcommittees were presented.

The report of the subcommittee on rural applications was presented by its chairman, C. H. Leatham (A '33). The part that electrical engineers must play in bringing electricity to rural areas was stressed in the report, which considered what the work of the subcommittee should be. Duplication of the work of other organizations or committees is to be avoided, and the task is seen to be one of studying work being done and following it up with suggestions from an engineering standpoint.

Wesley Weinerth (A '27) chairman of the subcommittee on wiring matters, presented a report which stressed the need for consideration of the domestic installation field and invited attention to the following points:

1. The general inadequacy of domestic wiring installations.

2. Possible postwar trend toward mass production of low-cost prefabricated homes which may require new methods of wiring.

3. The idea of introducing a so-called "ring-main" to supply the heavier appliance loads in the home.

4. Inclusion of convenience and safety in wiring design as well as sufficient capacity.

5. Consideration of an increase of minimum conductor size from number 14 to number 12 American wire gauge, a subject on which it was thought a comprehensive technical paper would prove helpful.

Discussions were solicited of a paper "Standards of Safety" which was read by S. B. Williams (M '37) at the conference session of the committee on domestic and commercial applications held during the 1943 AIEE winter technical meeting. A wiring session and conference at a future AIEE meeting was suggested, if sufficient papers could be obtained.

The report of the subcommittee on hazards to farm animals was presented by W. B. Buchanan (M '32) who discussed the conditions found on a number of detailed investigations of wiring installations on farms. A need was shown for further information in order to reach decisions regarding such matters as thorough grounding and the isolation of primary and secondary neutrals.

An opinion was expressed by Mr. Williams that the AIEE has been "ducking" the issue of safety, and that a subcommittee should be formed to investigate thoroughly the matter of hazards.

W. F. Ogden, chairman of the committee, presided, and M. K. Brody, secretary of the committee supplied the material from which this report was prepared.

## Quality Control Discussed at St. Louis Conference

Control of the quality of products manufactured by the electrical industry by means of statistical methods was the subject of one of the technical conferences at the AIEE 1944 summer technical meeting in St. Louis, Mo. Various aspects of the subject were covered in five conference papers, three by manufacturers' representatives, one by a representative of the United Stated Ordnance Department, and one describing educational courses on the subject. A. S. Langsdorf (F '12), Washington University, St. Louis, presided.

Mass-production methods require that some means of quality control be applied, declared R. E. Wareham, General Electric Company, Schenectady, N. Y. He explained how statistical methods had first been applied to telephone work, referring to the early work of Shewhart and others; now statistical methods are being widely applied throughout the electrical industry. Mr. Wareham explained how better quality can be assured through better design and how statistical methods assist in achieving both the best machines and best methods of manufacture. He also described briefly the co-operative work in quality control now being conducted jointly by five engineering organizations and added that the AIEE had been invited to participate.

An intensive educational course in quality control was described by Paul R. Rider, Washington University, St. Louis. This course is being given in various industrial centers throughout the United States, the American War Standards being used as texts. He said that the course is being taken by men in a wide variety of industries.

Captain A. R. Burgess, United States Army, explained how statistical principles are applied by the Ordnance Department to check the quality of finished Ordnance matériel. Premature firing is one of the most important defects to be guarded against, he said, and inspection of selected samples based on statistical principles has proved more effective than 100 per cent inspection. Different types of inspection are applied to different products, and the size of sample is varied to meet specific requirements.

The application of statistics to the manufacture of dielectrics was described in a paper (44-113) by C. M. Summers (M '39) and K. E. Ross, General Electric Company, Fort Wayne, Ind., which was presented by Mr. Summers. The value of statistical methods in establishing a specification that adequately describes an insulation material was pointed out. The control chart method based on an agreeable sample size was suggested for determining whether or not the material adheres to the specification. "A virgin field is represented in the transformation of the characteristics of the material into data suitable for design purposes," stated Mr. Summers, who added that "the statistical method provides a powerful tool for analyzing such properties as the effect of time and temperature on the properties of material."

The savings and improvements that result by the application of sampling tests as compared with 100 per cent inspection of finished products were pointed out by Joseph Manuele of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., who described a specific application of the method to the inspection of plastic pulleys. When the manufacture of this item first was begun, there was 78 per cent scrap. Through the application of statistical methods, the defects resulting in this high proportion of scrap were discovered and remedied. Design tolerances were found to be satisfactory, but the dimensions of the mold were found to be at fault. Mr. Manuele said that statistical methods were being applied to both the tools and the methods of manufacture and that they are valuable for checking both materials and processes.

## Temperature Standards Discussed in Two Conferences at St. Louis

Temperature standards for rotating machines in fractional- and integral-horsepower sizes were reviewed in two successive technical conferences (morning and afternoon) at the AIEE 1944 summer technical meeting held in St. Louis, Mo. These conferences represented a continuation of the activity begun at the 1944 winter technical meeting in New York. A series of conference papers was presented giving actual temperature-test results on various types and sizes of motors, by the following:

**B. M. Cain** (A'34) General Electric Company, Lynn, Mass.

**L. H. Hirsch**, Century Electric Company, St. Louis.

**F. A. Himebrook** (M'39) Master Electric Company, Dayton, Ohio.

**T. C. Lloyd** (A '31) Robbins and Meyers, Inc., Springfield, Ohio.

**R. F. Munier** (A '30) Emerson Electric Manufacturing Company, St. Louis.

**F. D. Phillips** (M '35) General Electric Company, Schenectady, N. Y.

**M. L. Schmidt** (M '41) General Electric Company, Fort Wayne, Ind.

**C. P. Potter** (F '39) Wagner Electric Corporation, St. Louis.

**W. R. Hough** (M '41) Reliance Electric and Engineering Company, Cleveland, Ohio.

The papers contained a large amount of data comparing temperature rise by thermometer, surface thermocouple, resistance, and embedded detectors, on open, totally enclosed nonventilated, and totally enclosed fan-cooled motors, with special emphasis on fractional-horsepower sizes. After presentation the papers were discussed at considerable length, and it was the consensus that in order to make this information available to the industry, the papers should be edited and published as a report of the committee on electrical machinery. A subcommittee, consisting of C. P. Potter, F. D. Phillips, and W. R. Hough has been appointed to do this editing. This committee hopes to make a permanent record of the figures that were submitted, in order that they may be available to all who may be interested, and particularly to the members of the AIEE committee on electrical machinery, the C-50 committee of the American Standards Association, and the general engineering committee of the motor and generator section of the National Electrical Manufacturers Association.

Presiding jointly at these conferences were F. E. Harrell (F '40) chairman of the AIEE committee on electrical machinery, and C. P. Potter (F '29) chairman of the subcommittee on induction machinery.

## AIEE Board of Directors Met During Summer Meeting

The regular meeting of the AIEE board of directors was held at the Hotel Jefferson, St. Louis, Mo., June 29, 1944.

Proposed amendments to the AIEE constitution, recommended by the committee on constitution and bylaws, were approved for submission to the membership for vote early in 1945. The bylaws were revised as follows:

*Section 67.* Changed to read:

Sec. 67. The Board of Examiners shall consist of not less than twelve Fellows of the Institute. The duties of this Board shall be those defined in Section 44 of the Constitution.

*Sections 30 and 31.* Revised to read as follows:

Sec. 30. There shall be ten geographical Districts numbered and named as follows:

| | |
|---|---|
| 1. North Eastern | 6. North Central |
| 2. Middle Eastern | 7. South West |
| 3. New York City | 8. Pacific |
| 4. Southern | 9. North West |
| 5. Great Lakes | 10. Canada |

With the exception of certain deviations, resulting from the provisions of Section 31 of these bylaws, the territory covered by each of the ten geographical Districts shall be as shown on page 00.

Sec. 31. Wherever the territory of any Institute Section lies in more than one geographical District, as defined in Section 30 of these bylaws, the entire territory of said Section shall be included in the geographical District in which the headquarters of the Section are located.

The following territory was added to the South Bend Section: Starke and Pulaski Counties in Indiana (from the Chicago Section); Marshall and Fulton Counties in Indiana and Cass and St. Joseph Counties in Michigan (from the Fort Wayne Section); Van Buren County in Michigan (from the Michigan Section).

The committee on Student Branches was authorized to send certain selected literature to each Student when he enrolls in the Institute. Upon recommendation of that committee, the designation "Enrolled Student," was changed to "Student Member," and this action was referred to the committee on constitution and bylaws for the necessary revision of the bylaws.

The board approved in principle a recommendation of the committee on members-for-life fund that an appropriate first use of the fund would be the payment of the expenses to the summer convention (or technical meeting) of each of five authors of the papers winning the District Branch paper prize in the even-numbered Districts in the even years and the odd-numbered Districts in the odd years—each author to present his paper in person on the regular summer meeting program. These awards are to be announced only for the summer meetings of 1945 and 1946 and decision with respect to future years is to depend upon the reaction of the membership in general and the Student members in particular.

Upon recommendation of the committee on industrial power applications, the Standards committee, and the finance committee, the board appropriated $4,700 for the publication of 10,000 copies of a report on "Electric-Power Distribution for Industrial Plants," developed by the committee on industrial power applications, to be sold at 75 cents per copy to members and nonmembers alike, with a discount of 20 per cent on purchases of ten or more copies.

Decision was made to hold the 1945 summer technical meeting in Detroit, Mich., June 25–29.

The board adopted a resolution expressing to the members of the general committee and all subcommittees which arranged for the 1944 summer technical meeting its appreciation of the effectiveness of their planning and conduct of the various features which produced, despite wartime conditions, a well-balanced meeting receiving the enthusiastic approval of those present.

Other matters discussed were:

Minutes of the meeting of the board of directors held May 25, 1944, were approved.

Recommendations adopted by the board of examiners at its meeting on June 15, 1944, were approved, and the following actions were taken: 7 applicants were transferred to the grade of Fellow; 27 applicants were transferred and 41 were elected to the grade of Member; 194 were elected to the grade of Associate; 133 Students were enrolled.

Appropriation disbursements for June 1944 amounting to $26,711.44 were reported by the chairman of the finance committee and approved by the board.

Those present were:

*President*—Nevin E. Funk, Philadelphia, Pa. *Vice-Presidents*—L. A. Bingham, Boulder, Colo.; A. G. Dewars, Minneapolis, Minn.; W. J. Gilson, Toronto, Ont.; C. R. Jones, New York, N. Y.; E. T. Mahood, Kansas City, Mo.; K. B. McEachron, Pittsfield, Mass.; C. W. Ricker, New Orleans, La.; E. W. Schilling, Bozeman, Mont.; W. E. Wickenden, Cleveland, Ohio. *Directors*—T. F. Barton, New York, N. Y.; M. S. Coover, Ames, Iowa; K. L. Hansen, Milwaukee, Wis.; C. M. Laffoon, East Pittsburgh, Pa.; T. G. LeClair, Chicago, Ill.; F. R. Maxwell, Jr., Pensacola, Fla.; C. W. Mier, Dallas, Tex.; S. H. Mortensen, Milwaukee, Wis.; W. B. Morton, Philadelphia, Pa.; W. R. Smith, Newark, N. J.; R. G. Warner, New Haven, Conn. *National Secretary*—H. H. Henline, New York, N. Y. Also present by invitation were: *Past President*—A. M. MacCutcheon, Cleveland, Ohio. *Incoming officers*—C. A. Powel, East Pittsburgh, Pa.; R. T. Henry, Buffalo, N. Y.; R. W. Warner, Austin, Tex; P. L. Alger, Schenectady, N. Y.; M. J. McHenry, Toronto, Ont.

**The smooth functioning of the summer meeting reflected careful and painstaking advance planning by the summer meeting committee which was ably headed by B. D. Hull (F '39) Southwestern Bell Telephone Company, St. Louis, Mo. Here Mr. Hull was looking over the day's program**

# ABSTRACTS ● ● ●

**TECHNICAL PAPERS previewed in this section will be presented at the Los Angeles technical meeting, Los Angeles, Calif., August 29–September 1, 1944, and are expected to be ready for distribution in advance pamphlet form within the current month. Copies may be obtained by mail from the AIEE order department, 33 West 39th Street, New York 18, N. Y., at prices indicated with the abstract; or at five cents less per copy if purchased at AIEE headquarters or at the meeting registration desk.**

## Air Transportation

**44-180—Alternating Current Versus Direct Current for Aircraft Radio Power Supply;** *D. E. Fritz (A '43), C. K. Hooper. 25 cents.* Aircraft radio power supplies generally have been selected to conform to the one type of power available on the airplane. New and larger aircraft are being developed which will have several types of power available for operating the radio equipment. In this paper a transmitter and a receiver have been analyzed to determine the weight, efficiency, reliability, and other important characteristics of the equipment. The fact that many voltages and frequencies are in use has influenced the authors to consider more than the basic subject of alternating current versus direct current and they have considered the power supplies in common use in addition to those being considered for use in the near future on new aircraft.

**44-179—Electric Automatic Pilots for Aircraft;** *P. Halpert (A '37), O. E. Esval (A '37). 20 cents.* The basic requirements of automatic pilots applied to airplanes are defined. Dynamic stability equations of the airplane are given in simplified form and the modified relations resulting from the superposition of automatic flight-control requirements are developed. The resulting equations establish some of the boundary conditions for the constants having to do with automatic pilot operation. An electric automatic pilot is described wherein functional control is obtained which substantially satisfies the equations. Various features of this automatic pilot, including automatic trim, automatic altitude control, and co-ordinated turn control are described. Performance characteristics are given and actual flight test data are included. The performance of this automatic pilot is shown compatible with theoretical requirements for the best suppression of attitude deviations of the airplane in any type of air turbulence.

**44-181—The Gyrosyn Compass;** *O. E. Esval (A '37). 15 cents.* The directional gyro, which has given such important service to flying, becomes more useful in the field of navigation when controlled by a method analogous to the erection of vertical gyros. An outline is given of the basic requirements for remote indicating compasses, which is a composite of demands from the Army and the Navy and other important groups. The general characteristics of the "Gyrosyn" compass, which was developed to meet these requirements is described. The importance of size, weight, and servicing considerations in obtaining stable magnetic-compass indications on airplanes subject to severe magnetic disturbances is demonstrated. The solution results in a compass system comprising a particular disposition of vital components. Extreme simplicity of those parts not convenient for servicing is adhered to rigidly.

**44-182—Solenoid-Operated Hydraulic Valves for Aircraft;** *G. A. Gorpfrich. 15 cents.* A combination hydraulic and electric control system may have advantages over either type used alone, particularly in semiautomatic and automatic operations where considerable work must be done during a short period of time. This combination can be achieved by the use of solenoid-operated hydraulic valves. Solenoid-operated valves need not be installed at the control point but may be installed at any point that permits shortest possible hydraulic line length. Therefore, the total weight and vulnerability of the hydraulic system are reduced. Since solenoid-operated valves are electrically controlled, they lend themselves to semiautomatic and automatic operation. This feature is of particular importance in combat airplanes, since automatic operations will relieve the pilot of at least some mental and physical effort during combat. The development of pilot-operated poppet valves and hydraulic fluids with comparatively flat viscosity curves are two of the more important factors which made possible the reduction in weight of solenoid-operated valves to a degree practical for aircraft usage.

**44-183—Electrically Heated Clothing;** *G. H. Wotring. 25 cents.* As early as 1918 the need for heated clothing for aviators was recognized and several thousand fur suits

containing heating wires were produced. In 1940 the engineers of the General Electric Company who had developed the electrically heated blanket constructed their first electrically heated flying suit from plans worked out in collaboration with the Wright Field clothing unit. After much testing and many revisions, a design was adopted and production started in September 1941. This suit was the blue woolen undersuit frequently seen in photographs of flyers preparing for a bombing mission. Many improvements have been made in the electrically heated suit, shoes, and gloves during the war and electricity also has been used to heat oxygen masks and goggles. In fact, the use of electric heat to keep the flyers in fighting condition on the long cold flights to their targets is one of the principal applications of electricity on modern military aircraft.

**44-184—Carbon-Pile Voltage Regulators for Aircraft;** *W. G. Neild. 15 cents.* Increasing demands on the electric systems of modern aircraft and the corresponding enlarging of their electric power supplies have necessitated the use of high-field-current voltage regulators to effect appreciable weight savings. Carbon-pile voltage regulators are capable of controlling high field currents within close limits of regulation. They are rugged in construction and can be adapted to many different applications in both a-c and d-c systems. Absence of step or vibrating contacts greatly reduces radio interference and other faults peculiar to those types of regulators. The smooth resistance change offered by the carbon pile assures the steady regulated output voltage which is vital to many radio applications. Various wattage sizes are available and many different resistance ranges are made possible by the proper selection of the carbon pile. Carbon-pile regulators are of great interest to anyone having voltage-regulation problems.

**44-186—D-C Arc Interruption for Aircraft;** *J. S. Quill (A '43), L. T. Rader (M '43). 25 cents.* This paper presents data on d-c arc interruption for voltages up to 250 volts at pressures from sea level to 50,000-feet altitude. Both resistive and inductive loads are investigated. The load range chosen includes small currents corresponding to relay or auxiliary contact values and higher currents associated with power circuits. Two general types of devices were used for the tests: single- and double-break switches and a blowout-type contactor. The results are presented both in the form of maximum amperes which can be interrupted and arcing time in milliseconds. The effect of inductive loads on arc interruption are discussed briefly. Unexpected results were obtained for the higher d-c voltages, the data showing better interruption at altitudes greater than sea level. The blowout-type contactor is shown to be capable of interrupting large amounts of power at all altitudes if attention is paid to its low current limitation. There also are presented the results of an investigation on the effect of a magnetic field on an arc, which at increased altitude tends to produce an arc movement in a direction opposite to that at sea level. No attempt has been made to give theoretical or analytical explanations of the results obtained.

**44-187—Electric Control in Automatic Pilots;** *C. M. Young (A '38), E E. Lynch, (M '35), E. R. Boynton. 20 cents.* Automatic pilots have been used satisfactorily to control aircraft attitude and course. They represent one step in the more complete problem of automatic flight control. Hence, their design and operation is of interest to those concerned with the more general flight-control problems. This introduction to automatic pilots defines the terms used in connection with them. It lists the qualifications for a satisfactory automatic pilot and states the purposes for which they are used. Understanding of their operation is simplified by describing first the fundamentals and then listing the equipment used to obtain this operation. The theory, from a qualitative point of view, is discussed with a simple mathematical analysis. A modern "relief" autopilot is described to illustrate specifically the decided advantages obtained by the recent conversion of some components to electrical operation.

**44-188—Considerations in Servomechanism Design;** *S. W. Herwald. 25 cents.* A servomechanism is, in general, any closed-cycle regulated system that is controlled by a difference of quantities. In this paper methods are outlined by means of which the steady-state and transient performance of servomechanism can be calculated. A general solution in operational form is given and specific solutions are derived for a number of different types of angular position servomechanisms. Among these is the solution for the Ward Leonard type of control with resistor-capacitor antihunt feedback. This is probably the most common type of angular position control.

**44-189—Design of an Ignition System for an 18-Cylinder Aircraft Engine;** *J. R. Harkness. 25 cents.* When initiating a new design, both the basic requirements and the desired advantages should be considered. The basic requirements for an aircraft ignition system are: sufficient voltage, at the proper time, over the full speed range, under all operating conditions and a system which fits the engine and airplane without interfering with any of the functions of the airplane. The desirable characteristics are: light weight and small bulk in a system easily installed and serviced, a minimum of maintenance, ease of manufacture by mass production methods, and a good physical appearance. These required and desired characteristics are discussed and some of the methods for obtaining them are presented. The concluding section of the paper is an elementary design analysis of the electric and magnetic circuits of an aircraft engine ignition system.

**44-190—A 40-Kva 400-Cycle Aircraft Alternator;** *H. E. Keneipp (A '40), C. G. Veinott (M '34). 20 cents.* A-c auxiliary-power systems for aircraft date back to World War I. Recently, numerous technical articles have indicated an intense revival of interest in this subject. Heart of any electric system is the generator which supplies electric power to all parts of the system. An alternator, especially designed and built for 208-volt three-phase systems, is described in this paper. Light weight and reliability dominate the design, which involved a large number of new and unusual problems.

**44-191—Inherent Overheating Protection of D-C Aircraft Motors;** *C. G. Veinott (M '34). 20 cents.* Inherent overheating protection undoubtedly is one of the major developments in the fractional-horsepower-motor field in the last decade. Thermal protection now is advocated by some for aircraft motors and many thermally protected motors are now in aircraft service. In this paper are reported the results of a number of laboratory tests taken on a typical aircraft motor. Tests were taken on a $^1/_{15}$-horsepower 7,500-rpm d-c motor. Loads ranged from locked-rotor to the minimum running load sufficient to trip the thermostat. Ambient temperatures ranged from −58 degrees centigrade to 78 degrees centigrade. Locked-rotor and running-overload temperature tests also were taken at a density altitude of 42,000 feet. Temperatures of the winding, frame, brushholders, and bearings were measured carefully under all conditions mentioned. Satisfactory protection without premature tripping invariably was achieved.

**44-193—Influence of Electricity on Aircraft Instrumentation;** *C. F. Savage (M '43). 15 cents.* The growth of the aviation industry during the present war has expanded the use of aircraft instruments and has set up conditions which have been very favorable to the electrification of aircraft instrumentation. The two factors which have been of primary influence have been the increase in size of aircraft and the wide range of operating conditions met by instruments. In order to indicate more clearly the expansion of electric instruments, two tabulations are included. One classifies aircraft instruments by functional use. The other tabulation identifies the operating principles of various kinds of aircraft instruments and subdivides them into their various classes. It is shown that many instruments are possible only because electrical principles are used in their design and it is shown also that certain few instruments which are relatively self-contained will continue to use only mechanical principles of operation. The necessity and advantages of electric systems for tachometers, gyroscopes, pressure instruments, automatic pilots, temperature indication, position indication, and compasses is discussed. The correlation between the individual measurements of a function and the adaptation to over-all systems is shown to be a major advantage of electric aircraft instruments. The adaptability of electric instrumentation to the most efficient power supply for the aircraft also is covered.

**44-194—Aircraft Electrical Accessory Vibration Investigation;** *D. R. Miller (A '42). 25 cents.* Flight measurements were made to determine the vibrations encountered by electric power-system accessories on four-engined bombardment aircraft. The flight tests were correlated with laboratory vibration tests to investigate design changes which were made to reduce failures of generator mountings and drive shafts and couplings. The paper presents flight vibration data and discusses investigations of causes of mechanical failures of generators. A general discussion of sources of vibration, accessory vibration response characteristics, and vibration test apparatus is presented. Recommendations are made for the mechanical design of accessories and their mountings.

**44-195—Electric Gun Turrets for Aircraft;** *J. D. Thompson* (*A '39*). *15 cents.* This paper briefly surveys the field of electric power drive equipment for aircraft gun turrets. Power drives are required for moving the guns against the high wind forces encountered in present-day aircraft slip-streams. They must be capable of fine control of speed and the speed must be smooth and constant under varying loads over a very wide range of speed and load. An overcompensated Amplidyne generator feeding a shunt motor is the system generally used. Speed is controlled by varying the Amplidyne excitation with a potentiometer; negative voltage feedback is used for stability. This gives a flexible system easily adapted to a variety of mechanical arrangements and auxiliary circuits which is being used successfully in large numbers in the present conflict.

**44-196—Airline Aircraft Electrical-Equipment Maintenance;** *W. A. Petrasek* (*A '36*). *20 cents.* The electrical maintenance problems of a typical commercial airline are reviewed and an outline of the required organization and procedure is presented. The design of electrical equipment for ease of maintenance is stressed and the importance of the electrical manufacturer's collaboration with the aircraft designer is emphasized.

**44-197—Requirements for Aircraft Electric Motors;** *E. R. Siefkin* (*A '43*). *15 cents.* Airplane designers constant insistence on reducing the weight of all parts of the airplane to an absolute minimum is having its effect on the design of aircraft electric motors. The slightly modified "general purpose" commercial motors of five years ago are rapidly being superseded by smaller, lighter, and more reliable motors designed for specific aircraft applications. In order that the optimum design may be achieved, the airplane manufacturer must furnish the motor designer with complete requirements for the specific application. The more important of these are described briefly with particular reference to 24-volt d-c motors.

**44-198—Some Aspects of the Application of Induction Motors to Aircraft;** *H. J. Braun* (*A '43*). *15 cents.* Fundamental characteristics of the three-phase induction motor are reviewed with respect to their possible application in aircraft. A brief review of present motor specifications is presented and test data are given on the operation of an induction motor with one or two lines shot away. Common types of motor loading are discussed with reference to the suitability of induction-motor drive for each. Curves are presented to illustrate the characteristics of motors and various types of loading.

**44-199—Paralleling and Regulation of 24–28-Volt D-C Generators in Multi-engine Aircraft;** *A. Siegal* (*A '42*), *D. DeCourcey* (*A '43*). *15 cents.* In this paper a revised electric bus system for aircraft is proposed which is intended to eliminate excessive variations in voltage and provide equal load division between generators and easier adjustment of component parts in service. Improved operational characteristics are obtained by regulating the voltages of the various generators at a common load center. These characteristics are obtained at no sacrifice of weight or vulnerability and without changes in the present equipment components.

**44-200—Peak Voltages With D-C Arc Interruption for Aircraft;** *V. E. Phillips* (*A '42*), *W. P. Mitchel* (*A '43*). *20 cents.* This paper presents experimental data on the high voltage peaks obtained with d-c interruption of an inductive circuit. Using a recently developed transient oscilloscope, peak voltages were measured on systems of 30, 60, 125, and 250 volts for simulated altitudes of from sea level to 50,000 feet. For the same voltage systems, peaks were measured for currents from 0.1 to 220 amperes, for double-break and single-break devices, and for loads ranging from pure resistance to very highly inductive. These loads included typical aircraft devices, such as motor fields and contactor coils, and the emphasis of this paper is on the application of the information to aircraft requirements.

**44-201—Functional Design of Aircraft Electric Actuator Equipment;** *C. E. Gagnier* (*A '43*). *15 cents.* The outline of this paper is included in its presentation to give a clear and concise picture of the factors that influence the design of an electric actuator for use on aircraft and to indicate the relative importance of the various factors. Chiefly interested in the design of this type of equipment are the electrical-engineering groups of the aircraft manufacturing companies, yet most of the problems involved are of a mechanical nature. For this reason, the paper mostly covers points of mechanical design on which the average trained electrical man is not fully informed. The length of the paper does not permit a complete solution of all design problems but does point out the existence of major problems and indicates the direction in which a rational design should proceed. This information will prove of value to the aircraft electrical engineer who must judge the work of the equipment manufacturer.

**44-202—Circuit Protective Devices in Aircraft;** *Walter Kenworth* (*Application pending*), *E. V. Sundt*. *25 cents.* Some of the many fuses and circuit breakers used particularly in aircraft are described. Conclusions which show the reasons for the particular shapes of fuses, the time–current curves, temperature coefficients, resistances, ratings, testing, and manufacture are given.

**44-203—A 120-Volt D-C Aircraft Electric System;** *L. M. Cobb* (*A '34*). *25 cents.* This paper describes the 120-volt d-c system and the equipment used on the Navy flying boat Mars, the service requirements, and the problems incidental to development and design of the components of the system. Calculated weights for several arrangements of generating equipment including the installed system are tabulated for comparison and the weight of the installed 120-volt d-c system is compared with the weight of the 28.6-volt d-c system. A summary report on flight tests and service operations provides the basis for conclusions relative to the practicability of 120-volt d-c for large aircraft.

**44-204—Basic Considerations in the Selection of Generators and Batteries for Aircraft;** *L. M. Cobb* (*A '34*), *H. M. Winters* (*A '40*). *15 cents.* The flight safety of modern military and commercial aircraft is dependent on electrically operated instruments, communication equipment, flight controls, and other accessories to such extent that all factors affecting the selection of installed generator and battery capacities must be given weighed consideration during the design period to obtain maximum reliability of service. This paper describes a method of evaluating electrical loading of an airplane under applicable operating conditions and discusses the most important general factors which must be considered in conjunction with loading in order to provide adequate electric power supply for each condition of operation.

**44-205—Problems in Applying Protectors to Electric Aircraft Motors;** *L. W. Buell* (*M '44*). *25 cents.* The most important problems in applying protectors to aircraft electric motors are:

1. To locate and measure the danger hot-spot temperatures in the motor.
2. To establish the life expectancy of each of these hot spots at different temperatures.
3. To decide the minimum life expectancy of the motor for the application on which it is to be used.

After this information is known, it is a relatively easy matter to apply a protector to the particular motor. This paper attempts to answer these three problems. Also included are suggested methods of testing and examples of some of the unusual problems that have been encountered in the application of protectors to aircraft motors. No attempt is made to answer the question of whether or not protectors should be specified for particular applications. This paper pursues the subject of protection of aircraft electric motors only after it has been decided as necessary for a particular application.

**44-206—The Development of Aircraft Position Lights;** *Jack Vitol*. *15 cents.* The need for a uniform system for the display and color of position lights on night-flying aircraft was demonstrated early in the history of aviation. Such a system was proposed at the Paris convention of 1919 and was adopted by many countries. Requirements of the Bureau of Air Commerce established as a result of the Air Commerce Act of 1926 stipulated the usage of lights which, in effect, conformed with this system. The need for additional light to give greater warning time for the faster aircraft in use by 1934 led to the requirement calling for a warning light. To meet this requirement, a 32-candlepower red lamp was used in at least one of the airplane's landing lights. With further increases in airplane speed and local congestion around airports, the results of a questionnaire indicated that the conspicuousness of aircraft had to be increased and such lights used as would be identifiable as belonging to an aircraft. Tests conducted resulted in using a two-color flashing light mounted on the tail of the aircraft and

flashing at a frequency of 40 cycles per minute. Supplementary top and bottom white fuselage lights were added and the flasher's circuit so wired that the red and green wing tip lights and the white taillight were on one circuit and the two white fuselage lights and the red taillight were on the other. This system of flashing lights has been in use now for almost two years and is being adopted either entirely or in part for use on certain military aircraft within the continental limits of the United States.

**44-207—Magnetic Clutch for Aircraft Electric Motors;** *Leo Andrews, Fred Shanely. 15 cents.* Electric motors equipped with clutch-brake mechanisms have various important applications on aircraft. In this paper the purpose and operation of such a device is described and a thorough analysis of the magnetic circuit, as well as the forces involved, is presented. A comparison of a calculated and a tested magnetization curve is made to prove the validity of the calculations within reasonable limits. Braking efficiencies of high-speed intermittent-duty aircraft motors are illustrated. Motors incorporating these mechanisms have been used successfully on aircraft for at least the past three years. They are operated in a life test laboratory for a minimum of 10,000 cycles through the Air Corps duty cycle of three minutes on—seventeen minutes off as a preliminary acceptance test.

**44-208—High-Altitude Brush Problem;** *Dimiter Ramadanoff (M '37), S. W. Glass. 20 cents.* Rapid brush wear encountered on military aircraft at high altitudes is traced to low partial pressures of oxygen and water vapor. Brush wear, coefficient of friction, contact drop, and temperature have been studied on copper rings in vacuum chambers. Electrographitic brushes wear rapidly in dry oxygen at pressures less than 17 centimeters of mercury and in water vapor at pressures less than 19 millimeters of mercury at brush temperature of 135 degrees centigrade. Brushes wear rapidly in dried hydrogen, nitrogen, carbon dioxide, and neon atmospheres at pressures up to 76 centimeters of mercury. Through the use of vacuum chambers, brushes were developed that operate satisfactorily on copper rings in the presence or absence of oxygen and water vapor. These tests were confirmed on actual machines in altitude chambers simulating flight conditions as well as on actual plane tests at high altitudes. Compensation of electric machines and its effect on sparking and general brush performance is discussed.

**44-209—A New High-Frequency Capacitor;** *W. M. Allison, N. E. Beverly. 15 cents.* This improved high-frequency capacitor has a low impedance over a wide frequency range. That effects due to inherent inductance of the conventional two-terminal capacitor have been overcome by the operation of this improved capacitor as a transmission line is evidenced by the complete absence of resonant effects in the range studied. It is a three-terminal network used most efficiently in the same manner as the low-pass filter. In physical appearance and size the new capacitor is similar to conventional capacitors of the same low-frequency capacitance and voltage rating. These novel characteristics can be used advantageously over a wide frequency range to filter or by-pass radio-frequency noise from direct current or low-frequency current circuits, as circuit elements in conventional filters, and to by-pass multiband receivers and transmitters.

**44-210—Design Considerations of 400-Cycle Aircraft Motors;** *M. B. Sawyer, Sr. 15 cents.* The choice of high-frequency a-c power supplies for aircraft motors has necessitated consideration of new factors in the design of the motors which will be used. The requirements to be met by motors in aircraft applications are reviewed. The characteristics of 400-cycle motors are demonstrated by showing the effect of operating a standard 60-cycle motor on 400 cycles. The principal problems which were not present in the use of d-c motors are the low starting torque and the high breakdown torque of the 400-cycle motor. Various methods of improving the starting torque are discussed in the light of their effect on other characteristics of the motor and methods of handling high breakdown torque are suggested.

**44-211—Very High-Frequency Radio-Noise Elimination;** *T. B. Owen (A '43). 25 cents.* This paper shows that the methods of eliminating radio noise at medium and high frequencies apply equally at very high frequency. The aircraft-engine ignition system is analyzed to determine how it acts as a generator of radio-influence voltages, currents, and fields and each of the possible coupling paths between the ignition system and the radio receiver is examined. The method of radio-noise elimination by determining the coupling path to the radio receiver and controlling this path is discussed. The coupling paths into the receiver are examined and, finally, a radio-noise test program is outlined by which each path is isolated. Methods for controlling the various paths are suggested throughout the paper so that the proper radio-noise elimination methods may be used.

**44-213—Radio-Noise Elimination in Military Aircraft;** *G. Weinstein, H. H. Howell (A '43), G. P. Lowe (A '43), B. J. Winter (A '42). 15 cents.* This paper outlines a method of radio-noise elimination by which a great deal of preliminary radio design work can be accomplished prior to the completion of the prototype airplane. Methods of noise coupling to the receivers, effective shielding and filtering methods, and a proposed method for determining the maximum allowable conducted radio-noise level are discussed.

**44-217—Brief Survey of Power-Supply Developments on British Aircraft;** *P. W. Carter. 15 cents.* This paper traces briefly the development of power supplies on British aircraft from early wind-driven generators to the latest dual-purpose machines which provide both d-c and a-c. A description is given of the self-regulating d-c generator which was the main equipment of British airplanes during the period between the use of the early windmill-driven generator with Tirrill regulator and the fitting of the modern shunt machine with interpoles and other improvements and its carbon-pile regulator. Voltage regulators and the British technique of current limitation are discussed in some detail together with new trends in circuit design. In the field of alternating current a description is given of a typical engine-driven alternator and the necessity for dual-purpose machines for single-engine aircraft are touched upon together with a description of the British units available for this double duty.

**44-218—Aircraft Electrical Horizons;** *F. W. Godsey, Jr. (M '36), W. L. Berry (M '43), T. B. Holliday (M '43). 15 cents.* The advantages and deficiencies of electrical apparatus as used in aircraft are reviewed from the critical standpoints of both the designer and the user of such equipment. Particular emphasis is given to the presentation of electrical possibilities and prospects of the near future in aviation and specific objectives are outlined for the benefit of the electrical designer and the development engineer.

**44-220—Solderless Terminals;** *F. H. Wells, J. C. Balsbaugh (M '35). 20 cents.* In the last few years solderless terminals have found an increasingly wide application. The fields of application include aircraft, shipboard, communication, and general industrial work. One of the most important reasons for their increasing use is the substantially decreased labor required in their application compared with soldered terminals. The use of solderless terminals also gives assurance of a greater degree of uniformity with respect to both mechanical and electrical properties for the terminal conditions of the electric circuit. In general, the use of solderless terminals in both manufacture and application permits uniform machine production to replace the hand work necessary for soldered terminals. The paper discusses the following: description and method of crimping the solderless terminals, corrosion test procedures and electrical measurements, effect of a wide range of currents through the terminals and different temperatures, conductivity stability with different types of corrosion tests, different contact metals with copper and aluminum, and the effect of relatively heavy currents and elevated temperatures.

**44-221—Historica Development of Electric Connectors;** *E. J. Neifing. 15 cents.* This historical treatment of the development of connectors endeavors to survey briefly the various stages of electric-connector design and the expanding applications of the uses from the earliest types for heavy-duty power applications to the smaller and more intricate fittings in aircraft, electronics, sound equipment, television, and marine applications. Because of the broad scope of the subject, the material is treated in generalizations in order to cover the history within the space limitations of this paper. It is believed that connector design, materials, and manufacture are keeping pace with the requirements of new electrical equipment. Since the connector is essentially a component part of electrical equipment, its development is affected by the requirements of new electrical equipment, and through adaptations for the improvement of existing equipment is increasing operating efficiencies.

**44-222—Electric Connections on Aircraft;** *F. O. Stebbins (M '39), L. A. Taylor. 25 cents.* Poor electric connections easily can cancel the tremendous advantages of electric systems which perform vital functions on aircraft. Satisfactory connections are obtained by careful engineering, high-quality manufacturing, 100 per cent inspection, correct installation and proper servicing. Many factors and design details must be considered in the design of electric connections according to their service. Among the permanent connections, the soft-soldered type must be made without damage to the wire, insulation, or nearby electric contacts. Crimped types must be controlled accurately to obtain consistent quality. The stud and terminal semipermanent type similar to *NAS*-17 through 22 is one of the most reliable for severe service. Quick disconnect types sacrifice a degree of reliability for the quick disconnect features. The *AN* types need special design and inspection in order to give good service. A German design is protected from dust and water. The contact surfaces of the German connector can be inspected and cleaned easily. Sliding and operating connections require special design, materials, and testing to operate over the wide temperature, pressure, and humidity ranges experienced on aircraft.

**44-223—Cable Used for Transmitting Electric Energy in Airplanes;** *M. F. Peters, J. J. Phillips, Max Kronstein, H. B. Jealous. 30 cents.* A method is proposed for determining the current capacity and the temperature of operation of cables in airplanes. The cable selected in combination with the power plant should result in the smallest weight for each electric unit converted into useful work. A general equation is given for selecting the optimum current which is expressed in terms of the weight of the cable, power plant and fuel, the length and resistance of the circuit, and the operating voltage of the system. All bus bars and conduit should be enameled or painted to reduce their operating temperatures. The greatest reduction in weight of the electric system will be accomplished by increasing the voltage. If strip conductors are used, terminal connectors may be eliminated and the connecting of aluminum conductors simplified.

**44-224—Requirements for Low-Voltage Aircraft Cable;** *R. E. Hedges (A '44). 15 cents.* This paper presents the basic requirements to be expected of any electrical cable which is considered for use in aircraft. A few of the problems encountered in forming a cable specification are presented along with factors to be considered in establishing valid test procedures. The author has not attempted to give solutions to the problems presented but rather has attempted to acquaint the reader with the fact that a major problem does exist in designing an electrical cable suitable for use in aircraft. Many factors which are extremely variable must be considered before an adequate solution can be found.

**44-228—Altitude Rating of Electric Apparatus;** *Paul Lebenbaum, Jr. (A '37). 25 cents.* This paper studies the effect of altitude on the ratings of rotating electric machines and, after determining the fundamental principles involved, discusses these in relation to the application of such machines in modern aircraft. It is shown that the rating of a self-ventilated direct-engine-driven aircraft generator decreases rapidly with altitude and, at some altitude within the operating range of the plane, the generator may be able to dissipate only its no-load losses. It is also shown that an air-scoop ventilated direct-engine-driven aircraft generator maintains its rating over most of the operating range of present-day aircraft. Finally, certain sea level tests are proposed from which calculations of rating under altitude conditions can be made.

**44-229—Plastics in Aircraft Electricity;** *E. B. Cooper. 25 cents.* The principal physical properties of plastics commonly used as electrical insulation in aircraft are described and some of the limitations of each are pointed out. Properties of some of the new materials of potential use as insulation are given to the extent that secrecy orders permit. It is pointed out that tables of physical data on plastics usually lack several significant data and are therefore somewhat misleading. Data are given for repeated impact and for heat distortion under several loads to illustrate the need for more information than is given by the standard single-blow impact and single-load heat-distortion tests.

**44-230—The Testing of Brushes for Life and Performance Under Various Altitude Conditions;** *C. J. Herman. 20 cents.* This paper presents the author's experience in the testing of brushes on machines intended for high-altitude service on aircraft equipment. The procedure and range of conditions found useful in testing a wide variety of small a-c and d-c machines are outlined in detail. It is hoped that other investigators will contribute their experiences through discussions or additional papers and that from this material there may be developed a suitable test code supplementing the present Institute test code for d-c machines. The only real criterion of brush performance is that of actual experience in service, since the infinite variety of conditions that affect brush performance all cannot be anticipated under test conditions. However, carefully conducted tests over a range of specified conditions do provide a good basis for brush selection and greatly expedite the final choice for the best over-all performance. For this reason, and because it will be helpful to investigators in comparing their results, it is hoped that the proposed brush test code may be undertaken in the near future.

**44-231—New Test Chambers for Aircraft Electric Apparatus;** *E. R. Summers (A '38), J. F. Settle (A '42). 30 cents.* When electric machines were taken to high altitudes of 25,000 to 40,000 feet on modern military aircraft, the brushes wore rapidly, insulation sometimes failed, lubrication was uncertain, windings overheated, and other vexing problems appeared. New materials and methods were needed for this new environment. To accelerate the development of aircraft apparatus, air-conditioned chambers are provided to duplicate the cold clean dry rarefied air of the stratosphere. Facilities being used to test a range of equipment from totally enclosed one-watt computer motors to pressure-ventilated 40-kva alternators are described. Reasons are given for the selection of specific equipment. From simulated high-altitude tests under controlled conditions, designers are completing new apparatus more quickly, are predicting its performance better, and are reducing the amount of flight testing required to develop new aircraft.

**44-233—Airplane Engine and Propeller Test-Cell Lighting;** *D. H. Tuck. 25 cents.* There were many test cells constructed with very little thought given to lighting in the early rush of war preparations. The same mistakes that were made in the early cells were repeated in the new cells. This paper outlines these mistakes and means of correction. It gives details of a study of the fundamental principles of lighting as applied to test cells, a survey of existing test cells, and a method of applying lighting calculations to test-cell design.

**44-234—Analysis of High-Frequency Ignition Circuits;** *A. W. Robinson, Jr. (A '41). 20 cents.* Several types of high-frequency ignition systems for aircraft engines are now undergoing development. Most of them incorporate a Tesla-coil circuit, including a high-frequency oscillation transformer shock-excited by capacitor discharge. This paper gives a theoretical analysis of such a circuit with special emphasis on the effect of circuit constants on the efficiency of energy conversion. Neglecting losses, a theoretical efficiency of 100 per cent is reached when the primary and secondary circuits have equal natural frequencies and when the coefficient of coupling between circuits is 0.60. A graphical method is given to evaluate the effect on output voltage of a change in primary lead inductance. The effect of resistance losses also is discussed briefly for cases of practical interest.

**44-237—Impedance of 400-Cycle Three-Phase Power Circuits on Large Aircraft and Its Application to Fault-Current Calculations;** *C. K. Chappuis (A '41), L. M. Olmsted (M '39). 30 cents.* The theory of symmetrical components is reviewed as a method for determining fault currents in aircraft circuits. Positive and negative sequence impedance values are presented in convenient form applicable to circuit configurations now designed. The conventional formulae for line-to-line and three-phase faults are included to provide complete working information. Zero-sequence impedance has required extensive investigation. A series of tests in aircraft is analyzed to determine compliance with conventional power-system theory. An analytical solution has been employed to extend the test data to wire sizes and configurations of circuits now designed for large aircraft. Proximity to the ground return path in the aircraft structure proves to be an important factor in the zero-sequence impedance, the effect of which is shown by suitable curves. By combination of these components the zero-sequence impedance may be determined for use in line-to-ground fault calculations.

**44-238—Higher-Voltage D-C Aircraft Electric Systems;** *W. L. Berry, J. P. Dallas. 20 cents.* Many of the advantages of 115-volt d-c aircraft electric power are presented with frequent comparisons to 24-volt d-c and 208/-120-volt 400-cycle three-phase a-c power. System reliability is emphasized. Weight comparisons, favorable to 115-volt d-c power, are shown for power generation, distribution, and load components. Problems concerning the use of the two high-voltage systems are discussed and compared. The popular belief that 115-volt d-c switching and commutation is unsatisfactory at high altitudes is refuted. It is concluded that 115-volt d-c is the lightest and most practical of the proposed electric systems for both medium and large airplanes.

**44-239—Applications of Electronics to Aircraft Flight Control;** *W. H. Gille (A '31), R. J. Kutzler. 15 cents.* Even automatic flight control has been improved by electronics. In the type C-1 autopilot, developed by Minneapolis-Honeywell for precision flight control in bombing, six potentiometers measure electrically any deviation of the airplane's position with respect to gyroscopic references. The potentiometers are connected in three separate bridge circuits, one for each control axis, so that the signals produced for each axis are added algebraically. Each composite signal is impressed on an amplifier which operates a servo motor to adjust the airplane's control surfaces. A balancing potentiometer on each servomotor is connected in the bridge circuit to make the circuit self-balancing as the motor produces corrective control surface movement. Thus the control surface movement is proportional to the original signal as determined by the flight deviation. By means of the autopilot control panel, the human pilot can both execute maneuvers and make adjustments for variations in flight conditions.

**44-241—Design Considerations for D-C Aircraft Generators;** *J. D. Miner, Jr. (M '42). 20 cents.* Engine-mounted aircraft generators must fit within an envelope $6^1/_2$ inches in diameter by 14 inches long. Electric-power requirements on military airplanes are increasing so rapidly that the most urgent assignment confronting designers of aircraft generators is that of achieving the ultimate output possible from this envelope. In 1939 the maximum rating was 1,500 watts; in 1940, the maximum rating jumped to 3,000 watts; in 1942, to 6,000 watts. A rating of 9,000 watts is coming into use, and a rating of 12,000 watts is likely to be possible in 1944. A rating of 15,000 watts has been mentioned. New materials, new military demands, new design ingenuity, new manufacturing techniques, and new operating experiences all have had a part in introducing more advances in this field during the past four years than were made during the approximate 20 years of generator history prior to 1938. Methods by which these advances have been accomplished are described, and possibilities for future progress are indicated.

**44-240—Instrumentation of 400-Cycle Aircraft Electric Systems;** *A. J. Corson (M '43), A. G. Stimson, W. A. Soley (A '36). 20 cents.* New conditions, imposed by the rapid advancement of aviation, have affected the electric systems on aircraft. Recent trends have indicated that some future airplanes will use a-c power systems operating at frequencies of about 400 cycles. This paper treats the problem of instrumentation for 400-cycle aircraft power systems where it is desirable to measure active and reactive power, frequency, voltage, and current. Careful consideration of weight and space requirements is necessary in view of the fact that five quantities will be measured on a-c systems by the use of four indicating instruments, as compared with only two quantities in the case of the d-c system. A set of four $2^1/_4$-inch square instruments and the necessary current transformers and external resistors are described. The design of these instruments and accessories has been controlled so that their combined weight totals 2.6 pounds, which does not exceed the weight of the d-c voltmeter and ammeter (including the external 50-millivolt shunt), for use on systems of equivalent capacity. The design procedures are presented and performance data are tabulated on this group of compact aircraft instruments.

**44-242—Solenoid-Operated Control Valves;** *V. W. Eckel, O. H. Wisegarver. 15 cents.* The present trend towards larger multi-engined aircraft has brought the question of various accessory power systems to the fore. This paper briefly summarizes some of the advantages of remotely controlled hydraulic circuits and suggests solenoid-operated valves as the most universally acceptable solution. Some of the problems involved in the design of solenoid valves are brought out and an acceptable design is described. Particular emphasis is given to the problem of matching the characteristics of the solenoid drive to that of the valve. The general conclusions are that:

1. The total installed weight of remote-controlled hydraulic systems is considerably lower than direct manually valved systems.

2. The simplicity and cost of the actual valve may have to be sacrificed to obtain the minimum installed weight.

3. Valves to be operated by solenoids should be designed for low operating forces and the solenoid force-travel curve should be made to match the valve curve to obtain the minimum total weight.

## Industrial Power Applications

**44-236—Vacuum-Tube Radio-Frequency Generator Characteristics and Application to Induction Heating;** *T. P. Kinn (Application pending). 30 cents.* Induction heating by radio frequency rapidly is taking its place in many industrial processes. The high-power vacuum tube, in the past used only in radio applications, now is generating radio-frequency energy for industrial use. To apply this energy properly to industrial-heating problems it becomes necessary that engineers active in all phases of industry understand the characteristics and limitations of the vacuum-tube radio-frequency generator. The fundamentals of the vacuum-tube self-excited oscillator and design considerations which determine the characteristics of the radio-frequency generator are reviewed and illustrated. In general the characteristics show a high-impedance constant-current variable-voltage generator which requires manipulation of load circuits to load the generator properly. Methods are illustrated for accomplishing proper loading and numerical examples are given illustrating the formula and procedure necessary to any induction-heating problem.

## Power Transmission and Distribution

**44-185-ACO—The Influence of Mutual Coupling of Transmission Circuits on Ground-Current Distribution;** *M. J. Lantz (A '43). 15 cents.* This paper discusses the causes and results of ground-current distributions that occur for a certain grouping of transmission circuits for single-phase-to-ground faults. These ground-current distributions result from the effects of mutual induction between intercoupled power-transmission circuits built in close proximity. Results discussed show that large unbalances of ground current in parallel circuits for faults external to them can occur from the influence of mutually coupled circuits. It is possible that the ground current flowing through a circuit to a more distant fault location can be considerably greater than the ground current flowing through the same circuit to a closer fault location. Large values of ground currents can be caused to circulate in a closed loop formed by parallel circuits which are coupled to another circuit carrying ground current. Ground currents can distribute unequally between similar parallel circuits which are affected unequally by mutual coupling.

**44-215—An Analysis to Determine the Optimum Bussing Arrangements and Transmission Capabilities at Grand Coulee;** *B. V. Hoard (M '36), G. W. Bills (A '38). 20 cents.* An unusual bussing arrangement at Grand Coulee generating station is described in this paper. It has been designated as the interleaved arrangement. The advantages offered by this plan include a reduction in circuit-breaker duty, an increase in system stability, and an increase in tran mission capability on lines that are heavily loaded. The plan further allows for maximum output of energy, which can be distributed in varying proportions to any one of three major load centers to compensate for diversity of local rainfall and hydroelectric generation. In solving the problem, the 230-kv bus was split but bus reactors were not used. Synchronizing power is obtained by interleaving lines from each load center to each bus. An increase in power in one load area is automatically available through decreases in other load areas without switching generators. Good operation also is obtained during emergency conditions with one line initially out of service, through use of spinning reserves and by arranging to drop a generator to prevent loss of stability.

**44-226—New 138-Kv Underground Cable Lines in Los Angeles;** *C. G. Mansfield (M '42). 30 cents.* The first 138-kv underground transmission cables to be installed west of Chicago and the largest now in use at this voltage (except for short station runs) were placed in service during 1943 by the Los Angeles Department of Water and Power. Although generally similar to 138-kv lines previously installed in the East, this installation involves a number of novel design features which make it of more than usual inter-

est. The paper describes these features and some of the studies of carrying capacity, cable movements, sheath voltages, oil supply and alarm, and sheath corrosion which led to their development and includes a summary of significant data and characteristics of the installation.

## Protective Devices

**44-192—230-Kv High-Speed-Reclosing Oil Circuit Breaker Tests;** *A. C. Schwager (M '31). 15 cents.* The advantages of high-speed reclosing of transmission lines in 20 cycles or less are well established for voltages up to 138 kv. Up to this date little experience is available however on reclosing 230-kv lines in 20 cycles or less, because breakers have not been available for such fast operation. This paper describes a 230-kv oil circuit breaker which is suitable for three-pole or single-pole reclosing with a reclosing time of less than 20 cycles. The performance of the breaker is established by field tests for high-speed-reclosing operation as well as for interruption of charging currents.

**44-214—Field Determination of Current-Transformer Errors by the Secondary-Voltage Method;** *E. C. Goodale (A'27), J. I. Holbeck (M'36). 15 cents.* A test method is described in which progressively increasing voltages are applied to the secondary winding of a current transformer with its primary winding open-circuited. This allows an exciting current to flow. The 90-degree lagging component of this current magnetizes the core whereas the inphase component supplies the core losses. The paper describes a field method of analyzing the two components. In combination with the impressed voltage they are converted to susceptance and conductance. For a multiratio transformer, a turn ratio of 40 to one is usually chosen. Values of susceptance and conductance are plotted as ordinates on log-log paper with secondary induced voltage as abscissa. A family of diagonal lines are drawn to represent all turn ratios. For any turn ratio, values of susceptance and conductance are derived from these curve data. With the burden resistance and reactance known the phase angle and ratio errors may be determined by substitution in two simple formulas.

**44-216—A New Distance-Type Relay With Adjustable Characteristics;** *S. L. Goldsborough (M '43). 15 cents.* This paper describes a new impedance distance-type relay with adjustable characteristics such that a partial or complete directional characteristic can be imparted to the impedance relay. This means that the impedance measurement in the direction of full load current and synchronizing surges from which the system can recover can be restricted very greatly without impairing the reach of the relay in the direction of fault ohms. A means is described for also varying the phase angle at which the directional characteristic is imparted to the impedance element. A discussion is given of a simple method of molding the relay characteristic to fit the short-circuit conditions of the line and load and synchronizing conditions of the system.

# PERSONAL ....

**L. M. Robertson** (A '27, M '38) transmission and station engineer, Public Service Company of Colorado, Denver, has been awarded the 1943 District 6 prize for best paper for his paper, "Electric Performance and Investigations at High Altitudes." He was born January 20, 1900, and received the degrees of bachelor of science (1922) and electrical engineer (1927) from the University of Colorado and the degree of bachelor of laws from Westminister Law School in 1930. Mr. Robertson entered the employ of the Public Service Company as an electric meter tester in 1923 and was transferred to the electric distribution department. During 1923 and 1924 he gained experience in the accounting department, the results department, and with the line, station, and substation repair and construction crews. In 1924 he entered the transmission and station engineering department and in 1925 was placed in charge of the department. During 1937 he was an instructor in electrical engineering at the University of Denver.

**A. E. Davison** (A '13, M '44) transmission engineer, Hydro-Electric Power Commission of Ontario, Toronto, has been awarded the 1943 District 10 prize for best paper for his paper, "Meteorological Services for Designers and Operators of Electric-Power Systems." Mr. Davison, who was born in Grenville County, Ont., April 5, 1881, holds the degrees of bachelor of arts and sciences (1905) and civil engineer (1914) from the University of Toronto. From 1906 to 1909 he was assistant superintendent and engineering assistant for the Buffalo (N. Y.) Pole Line Construction Company. During the latter period he also practiced as a consulting engineer. In 1909 he joined the Hydro-Electric Power Commission of Ontario as design engineer and was later given supervision of all field work. Since 1915 he has been transmission engineer for the Commission. At one time he served as a Royal Commission of one to report on the building and operation of transmission and distribution systems in the Province of Manitoba.

**J. W. Milnor** (A '13, F '30) transmission engineer, Western Union Telegraph Company, New York, N. Y., has been named consulting engineer. Mr. Milnor entered the engineering department of the Western Union company in 1913 and from 1919 to 1936 was research engineer. In 1936 he was made transmission engineer. He had charge of the development of the system now employed in sending photographs by submarine cable from London to New York. He is the author of a number of technical papers and holds several patents. **F. B. Bramhall** (A '31, M '39) formerly engineer in charge of the transmission laboratory will succeed Mr. Milnor as transmission engineer. Mr. Bramhall joined the Western Union company in 1920 and held the positions of assistant engineer, engineer, and engineer in charge of research laboratory before his appointment as engineer in charge of the transmission laboratory in 1936.

**J. G. Glassco** (A '08, F '28) general manager, public utility department, The City of Winnipeg (Man.) Hydro-Electric system, will retire in September 1944. Born in Hamilton, Ont., September 10, 1879, Mr. Glassco holds the degrees of bachelor of science and master of science from McGill University. His career in the utility field commenced with employment with the Montreal (Que.) Light, Heat and Power Company in 1901. He was superintendent for the Southern California Edison Company, Ltd., from 1903 to 1905 and in the latter year became chief electrical engineer for the Dominion Power and Transmission Company. In 1909 he was made chief electrical engineer for the power construction department of Winnipeg and was appointed power engineer in 1911. He was made manager of the Winnipeg Hydro-Electric System in 1912.

**W. R. MacDonald, Jr.** (A'33, M '44) AIEE assistant editor on leave, has been released from active duty with the United States Army Signal Corps and has returned to the Institute's editorial staff. He was born August 22, 1910, in New York, N. Y., and received the degree of electrical engineer from Cornell University in 1932. He was originally employed on the AIEE editorial staff in April 1934. A first lieutenant in the Officers Reserve Corps, he was called into active duty in January 1941 and was assigned to the Office of the Chief Signal Officer in Washington, D. C., as head of the editing subsection, literature section, military training branch, where he was responsible for the preparation of field and technical manuals for the Signal Corps. He was successively promoted to the ranks of captain and major.

**S. B. Farnham** (A '36, M '42) engineer in the central-station engineering department, General Electric Company, Schenectady, N. Y., has been awarded the 1943 District 1 prize for best paper as coauthor of the paper, "A New Control System for Automatic Parallel Operation of Load-Ratio-Control Transformers." Born in New Haven, Conn., June 23, 1912, he holds the degrees of bachelor of science (1933) and electrical engineer (1935) from Yale University. He entered the testing department of the General Electric Company, Schenectady, in 1935 and was transferred to the switchgear engineering department in Philadelphia, Pa., in 1936. Since 1937 he has been employed in the central station engineering department at Schenectady.

**H. C. Marcroft** (A '31) test engineer, Pennsylvania Water and Power Company, Baltimore, Md., has been awarded the 1943 District 2 prize for initial paper for his paper, "Use of Dielectric Absorption Tests in Drying Out Large Generators." He was born March 30, 1902, in St. Paul, Minn., and was graduated from the University of Minnesota with the degree of bachelor of science in electrical engineering in 1924. He was employed as student engineer by the Commonwealth Edison Company, Chicago, Ill., until 1925 when he was placed in charge of the technical work of the system operating department of the Illinois Northern Utilities Company, Chicago. In 1929 he became

test engineer with the Pennsylvania Water and Power Company.

**C. A. Laverty** (A '33) electrical inspector, Boiler Inspection and Insurance Company of Canada, Montreal, Que., has been awarded the 1943 District 10 prize for initial paper for his paper, "Causes and Effects of Damage to Electrical Machinery and Switching Equipment." He was born in Limestone, N. B., January 9, 1903, and was graduated from the University of Alberta with the degree of bachelor of science in electrical engineering in 1928. After completing the students apprentice course of the Canadian Westinghouse Company, Montreal, he was transferred to the service department in 1930. In 1931 he joined the Boiler Inspection and Insurance Company as electrical inspector.

**A. C. Marshall** (A '14, F '29) president and general manager of the Detroit (Mich.) Edison Company, has retired. Mr. Marshall commenced his career as engineer for the Public Lighting Commission of Detroit from 1894 to 1899. He was chief engineer of the Rapid Railway System from 1899 to 1904 and became general manager of the Port Huron (Mich.) Light and Power Company in 1905. In 1912 he joined the Detroit Edison Company as assistant to the president and was appointed vice-president in 1913. In 1940 he was elected president. He has been general manager since 1923. Mr. Marshall holds directorships in several other companies.

**Salvatore Minneci** (A '38) electrical engineer, power transformer division, General Electric Company, Pittsfield, Mass., has been awarded the 1943 District 1 prize for best paper as coauthor of the paper, "A New Control System for Automatic Parallel Operation of Load-Ratio-Control Transformers." Born in Palermo, Italy, November 13, 1899, he received his technical education in the Mechanics Institute and the Bliss Electrical School. He entered the testing department of the General Electric Company in 1924 and since 1925 has been engaged in transformer engineering.

**A. D. Hinckley** (A '27, M '38) formerly assistant to the dean of the faculty of engineering, and instructor in electrical engineering, Columbia University, New York, N. Y., has been appointed executive secretary of the Illuminating Engineering Society, New York. Mr. Hinckley has been an instructor at Columbia University since 1934 and assistant to the dean since 1940. He has been director of the university's war training courses. At present a director and member of the council of the Illuminating Engineering Society, he also has served as its general secretary.

**D. J. DeBoer** (A '34, M '41) chief electrical engineer, Loup River Public Power District, Columbus, Nebr., has been appointed director of the Copper Wire Engineering Association, St. Louis, Mo. A 1922 graduate of South Dakota State College, Mr. DeBoer joined the central station engineering department of the General Electric Company, Schenectady, N. Y., in 1922 and Sargent and Lundy, Chicago, Ill., in 1925. Employed by the Harza Engineering Company, Columbus, in 1934, he became chief electrical engineer of the Public Power District in 1936.

**H. R. Searing** (A '20, F '30) formerly vice-president in charge of electric and gas operation, Consolidated Edison Company of New York (N. Y.) Inc., has been appointed executive vice-president. Mr. Searing has been employed by the Edison company since 1909 as tester, inspector, cadet engineer, assistant engineer, assistant superintendent, and assistant electrical engineer. In 1939 he became engineer of operation and in 1940 was promoted to vice-president. He is a director of the Brooklyn Edison Company and the Yonkers Electric Light and Power Company.

**G. W. Swenson** (A '19, F '36) professor and head of the department of electrical engineering, Michigan College of Mining and Technology, Houghton, has resumed his duties after an 18-month leave of absence to serve as civilian consultant and operational analyst with the Army Air Forces, Orlando Fla. He was recalled to replace **Chester Russell** (A '29, M '34) associate professor and acting head of the department who resigned to accept the position of electrical engineer with the Chandeysson Electric Company, St. Louis, Mo.

**N. S. Hibshman** (A '27, F '41) formerly head of the department of electrical engineering, New York University, New York, has been appointed director of the school of science and technology of Pratt Institute, Brooklyn, N. Y. A graduate of Pennsylvania State College, Professor Hibshman commenced his teaching career at Lehigh University, Bethlehem, Pa., where he served as assistant professor and associate professor. He was chosen head of the department of electrical engineering of New York University in 1942.

**Edwin Fleischmann** (A '22, M '29) formerly deputy chief of the fuel and allocation branch of the Office of War Utilities, Washington, D. C., has joined the research department of Gilbert Associates, Inc., New York, N. Y. Before resigning to head the emergency curtailment unit of the War Production Board in 1942, Mr. Fleischmann had been associated since 1927 with the Niagara Hudson Power Corporation system in Buffalo and Niagara Falls, N. Y.

**J. F. Kotchevar** (A '38) electrical engineer, Janetta Manufacturing Company, Chicago, Ill., has been named chief engineer of the company. Mr. Kotchevar was graduated from the University of Minnesota in 1928 and entered the employ of the Ideal Electric Manufacturing Company, Mansfield, Ohio, as design engineer. In 1935 he was meter engineer with the Northwestern Public Service Company, Huron, S. Dak., and in 1936 joined the Janetta company.

**W. F. Westendorp** (A '35, M '43) research engineer, research laboratory, General Electric Company, Schenectady, N. Y., has been awarded the John Price Wetherill Medal of the Franklin Institute "in consideration of his development of a successful high-voltage low-frequency resonance transformer of relatively small size and light weight, which is shockproof, efficient in operation, and particularly suitable for uses in high-voltage portable X-ray units."

**J. N. Leedom** (A '44) research radio engineer, Naval Research Laboratory, Washington, D. C., has been awarded the 1943 District 7 Branch paper prize for his paper, "Ultrahigh-Frequency Transmission in Hollow Guides." Born July 27, 1921, in Dallas, Tex., he was graduated from Rice Institute with the degree of bachelor of science in electrical engineering in 1943. Since his graduation he has been associated with the Naval Research Laboratory.

**D. S. Young** (A '28, M '36) formerly district engineer, Anaconda Wire and Cable Company, Chicago, Ill., has joined the Canadian Wire and Cable Company, Toronto, Ont. Before joining the Anaconda Company in 1928, Mr. Young was associated with the Electric Bond and Share Company, the Detroit (Mich.) Edison Company, and the Winnipeg (Man.) Hydro-Electric System.

**F. B. Wright** (A '08) formerly eastern zone distribution manager, Western Electric Company, New York, N. Y., has been appointed director of public relations. Mr. Wright has been employed continuously by the Western Electric Company since 1922. He has been manager of the company's distribution houses in Baltimore, Md., Washington, D. C., and Chicago, Ill. He was transferred to New York in 1928.

**R. A. McCarty** (A '16, M '32) vice-president of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., has been granted a leave of absence to become special assistant to Maury Maverick, chairman and general manager of the Smaller War Plants Corporation, Washington, D. C. Mr. McCarty has been vice-president in charge of the Westinghouse company's subcontracting activities since 1941.

**C. S. Lumley** (A '23, M '29) formerly general manager, Roller-Smith Company, Bethlehem, Pa., has returned to the firm of Smith, Hinchman, and Grylls, Inc., Detroit, Mich., with which he was associated from 1926 to 1939 as industrial engineering manager. Mr. Lumley was district engineer for the Roller-Smith company in Chicago, Ill., and co-ordinating engineer and later general manager in Bethlehem.

**W. N. Goodwin, Jr.** (A '06, F '13) formerly chief engineer, and vice-president in charge of research, Weston Electrical Instrument Company, Newark, N. J., has been elected vice-president in charge of engineering. Mr. Goodwin, an employee of the company since 1898, has been chief engineer since 1906 and vice-president in charge of research since 1939.

**R. H. Marsh** (A '37) engineer, Southern California Edison Company, Ltd., Los Angeles, Calif., has been appointed chief engineer of the Machinery Manufacturing Company, Vernon, Calif. Mr. Marsh, who graduated from the California Institute of Technology, Pasadena, in 1936 entered the employ of the Southern California Edison company in 1937 as student engineer.

**H. C. Rentschler** (M '40) director of lamp research, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J., recently received the Frank P. Bowen Medal from the Franklin Institute "in consideration of his application of a source of bactericidal ultra-violet radiation in air-conditioning systems in a scientific and practical manner."

**H. J. Reeves** (A '30, M '41) formerly chief of the engineering division of the Spokane (Wash.) Area Office of the United States Engineer Corps has resigned that position to accept the commission of lieutenant, junior grade, in the United States Naval Reserve. Before the war he was a consulting engineer in Spokane.

**J. H. Harlow** (M '43) formerly assistant superintendent of the economy division, Philadelphia (Pa.) Electric Company, has been appointed assistant mechanical engineer in the mechanical engineering division. A graduate of the University of Maryland, Mr. Harlow has been employed by the Philadelphia Electric Company since 1923.

**J. M. Dollenmaier** (A '40) formerly manager of the Detroit metropolitan and Michigan districts of the Line Material Company has been appointed assistant to the vice-president. Mr. Dollenmaier, a 1930 graduate of the Armour Institute of Technology, joined the Line Material Company in 1934 as sales engineer.

**B. J. Wilkinson** (A '33, M '34) formerly administrative assistant to the manager has been made district manager of the Niagara, Lockport, Ontario Power Company, Olean, N. Y. Mr. Wilkinson was sent to Olean as sales manager in 1931, became new business manager in 1938, and administrative assistant in 1941.

**W. E. Goodwin** (M '33) formerly of the air-conditioning department, Westinghouse Elevator Company, Jersey City, N. J., has been appointed negotiation manager. Mr. Goodwin has been with the Westinghouse companies since 1915, serving the companies in Europe, East Pittsburgh, Pa., and Springfield, Mass.

**G. L. A. Thomson** (A '15, M '24) electrical division chief, Public Service Electric and Gas Company, Newark, N. J., has been appointed assistant to the laboratory engineer. Mr. Thomson was employed in the testing laboratory in 1906 and has been chief of the electrical division since 1923.

**R. J. Biele** (A '36) formerly component parts engineer, General Electric Company, Bridgeport, Conn., has been appointed assistant engineer of the receiver division of the electronics department. Mr. Biele has been employed by the General Electric Company since 1935.

**R. M. Gates** (M '35) president of the Air Preheater Corporation, New York, N. Y., recently received the honorary degree of doctor of engineering from Purdue University and was cited "man of talent and of devotion to duty; acclaimed leader of the profession of engineering."

**J. R. McFarlin** (A '07, M '26) electrical engineer, Electrical Services Supplies Company, Philadelphia, Pa., has been elected secretary of the company. Mr. McFarlin has been associated with the company since 1907 when he was graduated from the University of Delaware.

**L. H. Hardin** (M '41) formerly senior electrical engineer, Tennessee Valley Authority, Wilson Dam, Ala., has resigned to become principal electrical engineer of the Santee-Cooper operations of the South Carolina Public Service Authority, Columbia.

**T. R. Porter** (A '38) formerly sales engineer, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J., has joined the staff of the North American Philips Company, Inc., New York, N. Y., as technical-commercial expert on high-frequency heating.

**L. B. Bender** (A '20, M '27) retired colonel, United States Army, has been released from active military service and has resumed his position as engineer in the radio division, Westinghouse Electric and Manufacturing Company, Baltimore, Md.

**B. H. McCoin** (A '36, M '42) superintendent of the power bureau, Knoxville (Tenn.) Electric Power and Water Board, has been appointed field engineer in Atlanta, Ga., for the Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

**Zay Jeffries** (M '36, F '42) technical director, lamp department, General Electric Company, Cleveland, Ohio, has been elected to the board of trustees of Battelle Memorial Institute, Columbus, Ohio.

**C. J. Lake** (A '39) regulator engineer, induction voltage regulator department, General Electric Company, Pittsfield, Mass., has been transferred to the company's electronics division in Schenectady, N. Y.

**C. W. Mier** (A '25, F '39) engineer, Southwestern Bell Telephone Company, Dallas, Tex., has been elected first vice-president of the Texas Society of Professional Engineers.

**F. R. Longley** (A '25, M '42) electrical engineer, Western Massachusetts Companies, Springfield, has been elected vice-chairman of the electrical equipment committee of New England.

**F. A. Hubbard** (A '41) electrical engineer, New Bedford (Mass.) Gas and Edison Light Company, has been elected chairman of the electrical equipment committee of New England.

**G. O. Mason** (A '24, M '38) formerly electrical superintendent, Brown Shipbuilding Company, Inc., Houston, Tex., has been appointed assistant general superintendent for the company.

**S. B. Williams** (M '37) editor, *Electrical World*, New York, N. Y., has been elected president of the Illuminating Engineering Society.

**E. C. Balch** (A '22, F '43) chief engineer, Michigan Bell Telephone Company, Detroit, has been elected president of the Engineering Society of Detroit.

**T. C. Clarke** (A '35, M '42) district manager, Northern Electric Company, Vancouver, B. C., has been elected president of the Vancouver Board of Trade.

**Wright Canfield** (A '31, M '38) engineer, Public Service Company of Oklahoma, Tulsa, has been named director of the company's newly created research department.

**F. R. McMeekin** (M '40) formerly superintendent of transmission, South Carolina Electric and Gas Company, Columbia, has been appointed electrical engineer.

**P. P. Kinnaman** (A '22) formerly district operating superintendent, New Jersey Power and Light Company, Dover, has been made electrical engineer.

## OBITUARY ● ● ● ●

**Joe H. Gill** (A '12) chairman of the board and president, Electric Power and Light Corporation, New York, N. Y., and president of the United Gas Corporation died June 16, 1944. Born in Kerrville, Tex., September 25, 1886, Mr. Gill was graduated from the University of Texas with the degree of electrical engineer in 1910. After employment in the testing department of the General Electric Company, Schenectady, N. Y., from 1910 to 1912, he entered the employ of the Texas Power and Light Company, Dallas, for which he became general supervisor of design and construction of distribution and transmission systems. During World War I he served as first lieutenant in the United States Army. From 1919 to 1925 he was employed by the Dallas (Tex.) Power and Light Company first as salesman and later as assistant general manager of design, construction, and operation. He served as president and general manager of the Florida Power and Light Company, Miami, from 1925 to 1935 and as president of the Electric Power and Light Corporation since 1935.

**A. H. Armstrong** (A '98, M '04) retired engineer, died May 31, 1944. Born in Worcester, Mass., November 5, 1870, Mr. Armstrong was graduated from Worcester Polytechnic Institute in 1891 with the degree of bachelor of science in electrical engineering. Immediately entering the student course of the Thomson-Houston Electric Company at Lynn, Mass., he was transferred to Schenectady to work on a-c design in 1892 when the General Electric Company was organized. In 1894 he joined the engineering department and in 1897 the railway engineering department. Named consulting engineer of the transportation engineering department in 1929, he retired in 1930. He was a member of the National Electric Light Association, the American Railway Engineering Association, and the American Electric Railway Association.

**Bichat Xavier Gremillion** (M '41) division transmission engineer, Indiana Bell Telephone Company, Indianapolis, died May 28, 1944. Mr. Gremillion, who was born May 17, 1905, in Alexandria, La., received the degree of bachelor of science in electrical engineering from the University of Notre Dame in 1928. He entered the employ of the Indiana Bell Telephone Company as central office repairman, becoming student engineer in 1930. From 1933 to 1940 he was assistant engineer and in the latter year was made division transmission engineer.

**Louis Teker** (A '26) purchasing agent, Leeds and Northrup Company, Philadelphia, Pa., died June 11, 1944. Mr. Teker was born December 23, 1889, in Philadelphia and was graduated from Drexel Institute in 1912. Associated with Leeds and Northrup since 1909 he commenced employment as a draftsman and in 1916 was placed in charge of the purchasing department. He was a member of the American Society for Metals.

**William Andrew Jackson** (A '18, M '20) president, W. A. Jackson Company, Inc., Chicago, Ill., died June 1, 1944. He was born in Holden, Mo., August 6, 1872. After a period as general foreman of electrical construction for the Department of Electricity of the City of Chicago from 1896 to 1904, he formed the W. A. Jackson Company and served as its president until his death.

# MEMBERSHIP ● ●

## Recommended for Transfer

The board of examiners, at its meeting on July 20, 1944, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

### To Grade of Fellow

Adams, R. W., asst. district mgr., General Electric Co., Boston, Mass.
Fox, E. G., vice-president, Freyn Engg. Co., Chicago, Ill.
Knudsen, K. J., chief electronics engr., Lewis Engg. Co., Naugatuck, Conn.
Patterson, J. G., engr., New England Tel. & Tel. Co., Boston, Mass.

4 to grade of Fellow

### To Grade of Member

Ashmore, O. B., Navy Dept., Bureau of Ships, Washington, D. C.
Beeswy, R. J., asst. supt., Inland Steel Co., East Chicago, Ind.
Binford, H. F., associate elec. engr., N.A.C.A. Aircraft Engine Research Lab., Cleveland Airport, Cleveland, Ohio
Bohn, D. I., elec. engr., Aluminum Company of America, Pittsburgh, Pa.
Brown, A. W., asst. elec. distribution engr., Illinois Northern Utilities Co., Dixon, Ill.
Brown, M. J., design engr., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Brown, P. C., supt. of power, Whitehall Cement Mfg. Co., Cementon, Pa.
Caldwell, J. F., division engr., Georgia Power Co., Columbus, Ga.
Carlton, F. H., elec. engr., Sargent & Lundy, Chicago, Ill.
Conway, E. W., maintenance supt., Chesapeake & Potomac Tel. Co., Washington, D. C.
Cox, F. A., division engr., Public Service Comm. of Northern Ill., Maywood, Ill.
Cram, W. C., manpower co-ordinator, Bell Aircraft Corp., Marietta, Ga.
Duhamel, H. G., telephone engr., North Electric Mfg. Co., Galion, Ohio
Edwards, P. C., elec. engg., General Electric Co., Pittsfield, Mass.
Evans, Paul, design engr., Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Hango, J. R., asst. mgr., Aluminum Company o Canada, Ltd., Montreal, Que., Can.
Harvey, G. C., asst. section engr., General Elec. Co., Fort Wayne, Ind.
Howe, P. J., asst. chief engr., Western Union Telegraph Co., New York
Kalbach, J. F., asst. design engr., General Electric Co., West Lynn, Mass.
Lee, H. R., chief of marketing and sales div., Bureau of Reclamation, Denver, Colo.
Lethert, C. W., elec. engr., Northern States Power Co., Minneapolis, Minn.
Levy, M. W., elec. engr., Kansas City Power & Light Co., Kansas City, Mo.
Logan, E. W., chief elec. engr., Emerson Electric Mfg. Co., St. Louis, Mo.
Long, L. W., sales engr., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Matheis, C. E., asst. engr., Allis-Chalmers Mfg. Co., West Allis, Wis.
Maxwell, J. P., switchgear engr., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Michaelis, J. L., elec. engr., Pittsburgh Plate Glass Co., New Martinsville, W. Va.
Miller, G. W., engr. in charge, Line Material Co., Zanesville, Ohio
Montgomery, D., elec. engr., International Minerals & Chemical Corp., Austin, Texas
Moser, M. X., plant protection engr., Wisconsin Telephone Co., Milwaukee, Wis.
Osborne, H. R., design engr., Ferranti Electric, Ltd., Toronto, Canada
Piccardo, J. E., research engr., Fairbanks, Morse & Co., San Francisco, Calif.
Plusch, J. O., district elec. engg. officer, U. S. Coast Guard, Long Beach, Calif.
Poland, H. O., design engr., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Powell, C. S., contact engr., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Prideaux, C. F., project mgr., The Austin Co., San Diego, Calif.
Roessler, R. W., branch mgr., Westinghouse Elec. & Mfg. Co., Dallas, Texas
Ross, R. V., switchgear engr., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Seely, S., staff member, Mass. Inst. of Technology, Cambridge, Mass.
Sherwood, E. T., elec. engr., Globe-Union, Inc., Milwaukee, Wis.
Summers, E. R., induction motor engg. div., General Elec. Co., Schenectady, N. Y.
Thompson, J. K., mfg. engr., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wetherby, T. C., elec. engr., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wischmeyer, C. R., instructor in elec. engg., Rice Institute, Houston, Texas
Yeary, O. N., Fort Worth distribution supt., Texas Elec. Service Co., Fort Worth, Texas
Yosovitz, I. L., associate engr., Signal Corps Ground Signal Agency, Ft. Monmouth, N. J.

46 to grade of Member

## Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Any member objecting to the election of any of these candidates should so inform the national secretary before August 31, 1944, or October 31, 1944, if the applicant resides outside of the United States or Canada.

### To Grade of Member

Allen, E. F., Manning, Maxwell, & Moore, Inc., Boston, Mass.
Carnes, T. L., Amer. Tel. & Tel. Co., Chicago, Ill.
Constable, J. M., Westinghouse Elec. & Mfg. Co., Baltimore, Md.
Cornell, C. L., Jr., N. C. Shipbldg. Co., Wilmington, N. C.
Donnell, F. L., Pier Equip. Mfg. Co., Benton Harbor, Mich.
Durling, C. R., Jr., Monitor Cont. Co., Baltimore, Md.
Erickson, G. L. (Reelection), Western Union Tel. Co., New York, N. Y.
Feldmann, W. H. (Reelection), Elec. Mach. Mfg. Co., Minneapolis, Minn.
Frostick, H. G., Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
Gerszonowicz, S., Inst. de Elect., Montevideo, Urug., S. A.
Hardy, R. C. (Reelection), Gen. Elec. Co., Cleveland, Ohio
Houck, W. S., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Johnson, R. W., Corning Glass Works, Corning, N. Y.
Jones, C. R., Carolina Tel. & Tel. Co., Tarboro, N. C.
Kaar, I. J., Gen. Elec. Co., Bridgeport, Conn.
Lazard, P. J., French Mission, Washington, D. C.
McBrayer, C. T., Signal Corps, U. S. Army, Dallas, Tex.
Peters, M. F., Titeflex, Inc., Newark, N. J.
Penn, H. L., Amer. Tel. & Tel. Co., Atlanta, Ga.
Picken, D. A., I.C.I. Ltd., Dowlais, Wales
Pitman, J. B., Sr. (Reelection), Alum. Co. of America, Torrance, Calif.
Radcliffe, A. E., Thomas A. Edison, Inc., Cleveland, Ohio
Reid, O. W., South African Airways, Germiston, South Africa.
Rich, A. (Reelection), Alfco Products Co., St. Louis, Mo.
Rushton, W. A. (Reelection), Bristol Aero. Co., Ltd., Hawthorn, England
Seibert, W. J. (Reelection), Gen. Elec. Co., Atlanta, Ga.
Shepherd, J. E., Sperry Gyroscope Co., Garden City, N. Y.
Smith, C. E., Taylor Winfield Corp., Warren, Ohio
Sweatt, T. O. (Reelection), Burns & Roe, Inc., New York, N. Y.
Tuck, D. H. (Reelection), Holophane Co., Inc., New York, N. Y.
VanMarter, G. L., Davis Transf. Co., Concord, N. H.
Van Sickle, E., Van Sickle Radio & Sup. Co., Indianapolis, Ind.
Youngstrom, C. H. (Reelection), Imperial Irrigation District, Imperial, Calif.
Zillger, W. H., Line Material Co., Philadelphia, Pa.

34 to grade of Member

### To Grade of Associate

1. North Eastern

Bryson, R. W., U. S. Time Corp., Waterbury, Conn.
Cooke, E. F., Assoc.-Factory Mut. Fire Ins. Co., Boston, Mass.
Palmer, G. A., New England Pr. Serv. Co., Boston, Mass.
Smith, C. H., Boston Edison Co., Boston, Mass.

2. Middle Eastern

Aufderhaar, A. D., Westinghouse Elec. & Mfg. Co., Lima, Ohio
Bacon, W. L., U. S. Navy, Washington, D. C.
Barnes, L., Radio Corp. of America, Camden, N. J.
Carpenter, P. M., Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
Charlton, J. B., U. S. Navy Yard, Philadelphia, Pa.
Chevalier, J. H., National Elec. Coil Co., Columbus, Ohio
Dommin, L. A., American Ship Bldg. Co., Cleveland, Ohio
Gaugler, E. A., Naval Ord. Lab., Washington, D. C.
Harding, W. T., Major, Army Air Corps, Wright Field, Ohio
Jacobson, A. T. (Reelection), Allis-Chalmers Mfg. Co., Baltimore, Md.
Kenison, E. M., Federal Pr. Comm., Washington, D. C.
Reber, J. Gordon, Metropolitan Edison Co., Easton, Pa.
Wyatt, J. W., I-T-E Circuit Breaker Co., Philadelphia, Pa.

3. New York City

Brule, M. A., Gen. Elec. Co., New York, N. Y.
Cooper, E. B., E. I. du Pont de Nemours & Co., Arlington, N. J.
Lauinger, J. F., Jr., Conlan Elec. Corp., Brooklyn, N. Y.
Mujica-Quintanilla, L., Cia. Pervana de Telefonos, New York, N. Y.
Nittoli, A. J., U. S. Navy Yard, Brooklyn, N. Y.
Porter, H. R., Cent. Hudson Gas & Elec. Corp., Poughkeepsie, N. Y.
Swensk, A. L. (Reelection), Pub. Serv. Elec. & Gas Co., Newark, N. J.
West, W. B. (Reelection), U. S. Army, Fort Monmouth, N. J.

4. Southern

Graham, L. H., Major, U. S. Army, Robins Field, Ga.
Taylor, W. H., Elec. Storage Battery Co., Atlanta, Ga.

5. Great Lakes

Anderson, D. W., Northern Ind. Pub. Serv. Co., Hammond, Ind.
Blair, R. W., Gen. Motors Corp., Detroit, Mich.
Carroll, J. C., Jr., Hubbard & Co., Chicago, Ill.
Heinrich, K., Allen-Bradley Co., Milwaukee, Wis.
Hudson, W. J., Allen-Bradley Co., Milwaukee, Wis.
Lincoln, E. W., Fansteel Metallurgical Corp., North Chicago, Ill.
Lusher, M. H., Pub. Serv. Co. of Northern Ill., Chicago, Ill.
Lyons, C. E., Burroughs Adding Mach. Co., Detroit, Mich.
Meyer, J. C. (Reelection), Allen-Bradley Co., Milwaukee, Wis.
Peter, C. R., Allis-Chalmers Mfg. Co., West Allis, Wis.
Mahnke, E. C. (Reelection), 1400 E. 53rd St., Chicago, Ill.
Smale, V. E., Sparks-Withington Co., Jackson, Mich.
Whitton, A. W., Pub. Serv. Co. of Northern Ill., Evanston, Ill.
Williams, V. E., Dachel-Carter Shipbldg. Co., Benton Harbor, Mich.

6. North Central

Atkinson, R. G. (Reelection), Public Service Co. of Colo., Denver, Colo.

7. South West

Berwald, C. H., U. S. War Dept., Dallas, Texas
Collins, A. F., Moloney Elec. Co., St. Louis, Mo.
Phelps, G. O. (Reelection), Texas A. & M. College, College Station, Texas
Smith, G. A., Jr., Central Station Alarm Co., Dallas, Texas

8. Pacific

Berry, J. L., Westinghouse Elec. & Mfg. Co. Los Angeles, Calif.
Keehner, L. W., Moore Dry Dock Co., Oakland, Calif.
Ung, P. F., Hughes Aircraft, Culver City, Calif.

9. North West

Dickinson, H. K., Montana Pr. Co., Great Falls, Mont.
Drescher, R. D., Boeing Aircraft Co., Seattle, Wash.
Fernald, G. W., Puget Sound Navy Yard, Bremerton, Wash.
Hart, V. B., Boeing Aircraft Co., Seattle, Wash.
Hedin, E. R., Montana Pr. Co., Great Falls, Mont.
Hughes, P. R., Montana Pr. Co., Great Falls, Mont.
Karr, G. M., Montana Pr. Co., Great Falls, Mont.
Schubert, K. L., Boeing Aircraft Co., Seattle, Wash.
Sheppard, J. J., Jr., Boeing Aircraft Co., Seattle, Wash.
Suskin, H. H., Boeing Aircraft Co., Seattle, Wash.

**Elsewhere**

Bolus, J. E., Electricity Dept., Coventry, England
Campoy, H., Maguinaria y Materiales S. de R. L., Nogales, Mex.
Cotton, H. M., Radio Dev. Lab., Wellington, N. Z.
Johanson, H. A., Lago Oil & Transport Co., Aruba, N. W. I.

Total to grade of Associate

United States and Canada 59
Elsewhere 4

## SPEE Committee Reports on Postwar Engineering Education

The committee on engineering education after the war of the Society for the Promotion of Engineering Education has completed a report which was published in the *Journal of Engineering Education* for May 1944, and presented at the society's fifty-second annual convention, Cincinnati, Ohio, June 22–25, 1944. The committee operated under a directive to study the urgent problems of the immediate future as well as longer range problems of educational principle and practice, and particularly to review a 1940 report on aims and scope of engineering curricula in the light of future conditions as they can now be envisaged.

The 1940 report advocated the strengthening of engineering education by concentration on basic elements in the undergraduate years, organization of the curriculum in parallel integrated sequences of scientific-technological and humanistic-social subjects, and transfer of some of the more specialized subjects to the postgraduate period. The exigencies of war have tended to cause a reversal of the recommended process because special war training programs necessarily must be concentrated on the attainment of specific technical objectives. The committee now believes that with the cessation of hostilities the policy of expediency in engineering education should be abandoned and the evolutionary process of strengthening engineering education at its base resumed as quickly as possible.

In attacking its assignment the committee considered first matters of general policy, which are discussed in part I of the present report, and second, specific problems of the postwar period, which are discussed in part II. These specific problems include the adjustment of curricula to the needs of returning veterans, the adaptation of the college calendar to the postwar transition period, the possible effects of future universal military service, the rehabilitation of faculties, the restoration and strengthening of postgraduate study and research, and the study of lessons learned from war experiences that may be applied to the permanent benefit of engineering education.

Two general meetings were held by the committee, while other meetings were held by smaller groups preparing drafts of the report. These were reviewed by the entire committee, and a version circulated among a large group of educators both in and outside of engineering education.

Three major groups of students for whom plans should be laid are foreseen. These are:

1. Those who would follow engineering programs of the usual pattern, but with some modification.
2. Those preparing for careers in the operation and management of industry.
3. Those who would be fitted for unusual scientific and creative accomplishments.

Differentiation of curricula for the three groups would begin after the third year. Courses for the first two groups would require a total of four years, and for the third group five or more years.

The report suggests that changes may be necessary in order to meet criticism that there is waste in operating educational facilities less than a full calendar year, and foresees inevitable problems of financing higher education during a period of world-wide economic rehabilitation.

Members of the committee on engineering education after the war were H. P. Hammond, *chairman;* J. W. Barker (F '30), F. L. Bishop, E. S. Burdell, R. E. Doherty (F '39), N. W. Dougherty, H. T. Heald, F. G. Higbee, Sidney Kirkpatrick, C. E. MacQuigg, F. T. Mavis, E. L. Moreland (F '21), D. B. Prentice, H. S. Rogers, A. R. Stevenson (F '37), B. R. Teare (F '42), W. E. Wickenden (F '39) F. L. Wilkinson, B. M. Woods, W. R. Woolrich, and C. R. Young.

# EDUCATION • • •

### Veteran Program Augurs Postwar Boom for Colleges

American colleges and universities, which will be operating this fall at less than 40 per cent capacity, are facing the biggest educational boom in their history, according to an article in a recent issue of the *United States News.*

The tremendous enrollment increase expected will reflect two postwar conditions—an influx of returning veterans, honorably discharged from active military and naval service, who will continue their interrupted educational programs at Government expense, and the normal progression from high school to college of graduates no longer subject to drafting for selective service.

The first of these groups will be composed of all men and women who entered upon active duty in the Armed Forces after September 16, 1940, and before reaching the age of 25 who can claim any interference with their education because of service. Every veteran falling into this general classification who can meet the entrance requirements is entitled to a year's training in an approved college or technical school of his own choosing. The Government will pay up to $500 for his tuition and fees for the school year, and will give him a subsistence allowance from $50 to $75 a month. Longer service entitles him to as much as four years in college, studying straight through the calendar year, if he wishes, so as to get a full college course and two years of medicine, law, or graduate study in addition. There is no limit to the educational level, and the individual may engage in either full-time or part-time study.

The boom is not expected to manifest itself either immediately or suddenly, but the real influx will come, of course, with demobilization. The American Council on Education advises that from a possible million veterans returning to educational institutions, 250,000 to 400,000 probably will enroll on the college level. Because of the differences in their past training and the time lapse since their last period of study, the colleges are shaping courses and programs to fit the needs of four groups of students from the armed services. These groups are:

1. High-school graduates without college training.
2. Students who entered high school but did not finish.
3. College students.
4. College graduates.

The veteran in this first group of nearly 4,000,000, is as much as four years behind in his studies. However, with sufficient length of active service he may equip himself in two to four years to be a radio engineer, a businessman, a doctor, or a lawyer. Or in a year in the right college, he can train for a skilled mechanic's job or a position in business. Special tutoring and preparatory courses are being sponsored by many of the colleges for veterans in the nongraduate group. When this veteran is ready for college classes, he has the same choice as the graduate, or he may turn to a two-year course in a technical institute or junior college. A student from the group of 1,200,000 who started in college but did not finish may go on to graduation at his former college or a new one. Graduate doctors and lawyers will be allowed to take refresher courses or go on for further specialization, and older veterans with little or no college training can brush up on agriculture, business methods, or advertising.

One of the major problems the colleges are facing is how to adapt their programs to meet both the needs of veterans anxious of the speediest possible completion of their training and of the recent high-school graduates not accustomed to accelerated study.

# INDUSTRY • • • • •

### New Electrical Insulation Promises Higher Ratings

Insulating materials made from sand, brine, coal, and oil that have exceptional heat resistance offer major benefits to the electrical industry in the form of reduction of size and weight of equipment for a given output, increased life, or operation under conditions previously impossible.

The new materials are part of a series of substances, known as silicones, in the field of polymer chemistry lying between that of glass on the one hand and of organic plastics on the other which have been investigated by the Dow Corning Corporation, a new company formed by The Dow Chemical Company and the Corning Glass Works.

## Future Meetings of Other Societies

**American Association for the Advancement of Science.** Annual meeting, September 11–16, 1944, Cleveland, Ohio.

**American Chemical Society.** 108th annual meeting, September 11–15, 1944, New York, N. Y.

**American Society of Mechanical Engineers.** Fall meeting, October 2–5, 1944, Cincinnati, Ohio; annual meeting, November 27–December 1, 1944, New York, N. Y.

**Association of Iron and Steel Engineers.** Annual meeting, September 25–27, 1944, Pittsburgh, Pa.

**Edison Electric Institute.** Accident prevention committee, September 12–13, 1944, New York, N. Y.

**Electronic Parts and Equipment Industry Conference.** October 19–21, 1944, Chicago, Ill.

**Illuminating Engineering Society.** Annual convention, September 14–16, 1944, Chicago, Ill.

**Institute of the Aeronautical Sciences.** Air transport meeting, September 1944, Washington, D. C.; fall meeting, November 1944, Dayton, Ohio.

**National Electrical Manufacturers Association.** October 23–27, 1944, New York, N. Y.

**National Electronics Conference.** October 5–7, 1944, Chicago, Ill.

**National Industrial Chemical Conference and Third National Chemical Exposition.** November 15–19, 1944, Chicago, Ill.

**National Safety Congress of the National Safety Council.** October 3–5, 1944, Chicago, Ill.

**Society of Motion Picture Engineers.** 56th semiannual fall conference, October 16–18, 1944, New York, N. Y.

Commercially available silicones include water-white fluids that remain at the temperature of dry ice as fluid as water, other fluids with the consistency of honey over a wide temperature range, varnishes and resins for use in electrical equipment where high-temperature operation is desired, and lubricating greases for uses involving high and low temperatures and chemical resistance.

Silicone materials for electrical insulation bridge the gap between conventional organic insulating materials and ceramic-type materials. Physically they are similar to conventional resins, varnishes, and organic structures, but they do not readily decompose at temperatures of the order of 200 degrees centigrade. In conjunction with glass-fiber and mica insulations, the new materials open many possibilities.

**Electric Rates Reported by FPC.** Typical electric bills for residential service in all communities of 2,500 population and more in the United States as of January 1, 1944, are shown in report FPC R-28, issued by the Federal Power Commission, Washington, D. C., and available at 25 cents per copy. The report includes typical net monthly bills for 15, 25, 40, 100, 250, and 500 kilowatt-hours of residential service in the communities covered.

**Film for War Workers.** "Brief for Invasion" is the title of a 33-minute motion-picture film produced by the War Department Bureau of Public Relations and available for exhibition to audiences of war-plant employees. Timed to coincide with present operations in Europe, the film is intended to show workers in war industries their role in invasion. Scenes from combat and captured German films are included, together with animated diagrams of German defense systems, to impress the need for an uninterrupted flow of matériel.

# JOINT ACTIVITIES

## Scientific Personnel Needed for New War Projects

The Office of Scientific Personnel of the National Research Council has been receiving a large number of requests for scientific and technical personnel from industrial and governmental laboratories interested in research personnel, from colleges interested in teachers, and from industrial establishments interested in a wide variety of scientifically trained persons.

Employers are most interested in candidates trained in physics, mathematics, geophysics, engineering (especially electronics, communications, electrical, mechanical, chemical), and neighboring fields.

The Office of Scientific Personnel, set up to serve in the war emergency, is in a position to refer an able scientist to employers engaged in urgent work. Therefore it is suggested that any persons who are, or who may be available for employment in the specified fields write to:

Dr. M. H. Trytten, Director
Office of Scientific Personnel
National Research Council
2101 Constitution Avenue
Washington 25, D. C.

## AIEE Members Invited to Discuss ASCE Paper

Attention of AIEE members is called to the invitation from D. B. Steinman, consulting engineer, New York, N. Y., to participate in the written discussions of his paper, "The Rigidity and Aerodynamic Stability of Suspension Bridges," published in the November 1943 Proceedings of the American Society of Civil Engineers.

Mr. Steinman says: "The paper... embraces phases of the problem in which engineers of other branches of the profession are interested and can make authoritative contributions. The bridge engineer needs the co-operation of experts in other fields, notably in the fields of vibration analysis and aerodynamics, if a complete solution is to be attained."

# LETTERS TO THE EDITOR

**INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.**

## Some Aspects of Inductance When Iron Is Present

*To the Editor:*

In the paper, "Some Aspects of Inductance When Iron Is Present," by L. T. Rader and E. C. Litscher (AIEE *Transactions*, volume 63, 1944, March section, pages 133–9) the authors state on page 135 that an accurate analytical expression for the saturation curve is quite unwieldy if it is desired to express $B$ as a function of $H$. It also raises such questions as:

1. How can the relation between current and time best be found?

2. How can the stored energy and thence the inductance be found?

There exist various ways in which a saturation curve can be represented analytically such as algebraic or transcendental expressions and power, trigonometric, or other series. Considerable difficulty usually is encountered when any of these is substituted in differential equations and general solutions attempted. Still another way is to replace the actual curve by one consisting of two or more straight lines and to apply a linear solution to each part. Few solutions in which a power series has been used for the foregoing purposes have been published. A pair of such solutions follows.

In any given magnetic circuit, the relation between flux or flux density and ampere turns or current can be represented by

$$\phi = AB = a + bi + ci^2 + di^3, \text{ and so forth} \qquad (1)$$

This includes saturation, hysteresis, magnetic leakage, and air gaps but not eddy currents which lead to more difficult mathematics involving Bessel functions. For many purposes two or three terms are sufficient.

Consider a 300-turn 0.09-ohm coil wound on a laminated core with an area of one

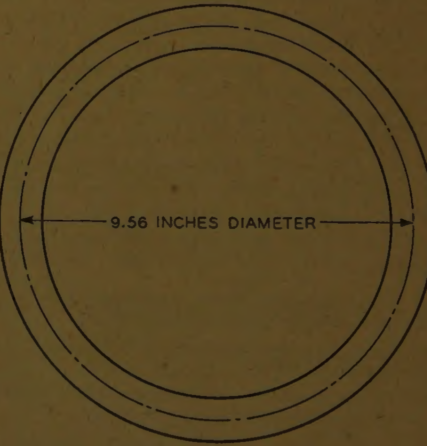


Figure 1

square inch and a mean circumference of 30 inches (Figure 1). From the saturation curve in Figure 2, we read for three points taken arbitrarily and obtain the statistics arranged in Table I.

**Table I**

| Density | Ampere Turns Per Inch | Ampere Turns | Amperes |
|---|---|---|---|
| 66,000 | 30 | 900 | 3 |
| 88,000 | 60 | 1,800 | 6 |
| 99,000 | 90 | 2,700 | 9 |

To determine the coefficients $b$, $c$, $d$, write equation 1 for each of these three points

$$\left.\begin{aligned}\phi=AB=3b+3^2c+3^3d=66{,}000\\ 6b+6^2c+6^3d=88{,}000\\ 9b+9^2c+9^3d=99{,}000\end{aligned}\right\}\qquad(2)$$

and solve simultaneously to give

$$\left.\begin{aligned}b&=33{,}100\\ c&=-4{,}280\\ d&=204\end{aligned}\right\}\qquad(3)$$

From this, the relation between flux and current

$$\phi=33{,}100i-4{,}280i^2+204i^3$$

and its time derivative,

$$\frac{d\phi}{dt}=(33{,}100-8{,}560i+612i^2)\frac{di}{dt}\qquad(4)$$

When this coil is connected suddenly across a d-c electromotive force of $E=0.993$ volt, the current must satisfy the equation

$$\frac{N}{10^8}\frac{d\phi}{dt}+ri=E\qquad(5)$$

or, after substituting from equation 4 and transposing

$$\frac{di}{dt}=\frac{0.993-0.09i}{0.0993-0.0257i+0.00184i^2}\qquad(6)$$

Equation 6 can be integrated by one of the finite difference methods (those of Euler, Kutta, Runge, Adams, Piaggio, and others) or by transposing, dividing out, and integrating to find $t$ in terms of $i$, from which

$$t=-0.0102i^2+0.06i-0.441\times\log_e(0.993-0.09i)+C\qquad(7)$$

$t=0$ when $i=0$ so that the constant of integration $C=0.441$ log 0.993 and the final solution

$$t=-0.0102i^2+0.06i+0.441\log_e\frac{0.993}{0.993-0.09i}$$

$$=-0.0102i^2+0.06i+1.015\log_{10}\frac{1}{1-0.0906i}\qquad(8)$$

From equation 8 we obtain the values in Table II.

**Table II**

| i | t | i | t |
|---|---|---|---|
| 0 | 0 | 9 | 0.469 |
| 2 | 0.167 | 10 | 0.593 |
| 4 | 0.275 | 10.5 | 0.844 |
| 6 | 0.339 | 11.03 | |
| 8 | 0.397 | | |

When plotted this gives curve $A$, of Figure 3, similar in shape to that of Figure 13 in the paper. If a different number of terms had been used in equation 2, the work would have been similar. This is true also for the case of decreasing currents.

When the saturation curve is replaced by two straight lines as in Figure 2, the procedure is:

for lower part, inductance

$$L=\frac{\phi}{i}\frac{N}{10^8}=\frac{75{,}000}{3}\times\frac{300}{10^8}=0.075\text{ henry}$$

$$\text{current } i=\frac{E}{R}\left(1-e^{-\frac{R}{L}t}\right)=\frac{0.993}{0.09}\times\left(1-\epsilon^{-\frac{0.09}{0.075}t}\right)\text{ amperes}$$

at knee where

$$I=3,\quad t=\frac{L}{R}\log_e\left(\frac{1}{1-\frac{RI}{E}}\right)=\frac{0.075}{0.09}\times$$

$$\log_e\left(\frac{1}{1-\frac{0.09\times3}{0.993}}\right)=0.265\text{ second}$$

at intermediate point

$t=0.13$ second, $i=1.59$ amperes

for upper part, inductance

$$L=\frac{25{,}000}{9.5-3}\times\frac{300}{108}=0.0115\text{ henry}$$

current

$$i=\frac{E}{R}+\left(I-\frac{E}{R}\right)e^{-\frac{Rt}{L}}=\frac{0.993}{0.09}+\left(3-\frac{0.993}{0.09}\right)e^{-\frac{0.09}{0.0115}t}\text{ amperes}$$

where $t$ is counted from the knee ($t=0.265$), from which we can deduce the data in Table III.

**Table III**

| t | t+0.265 | i |
|---|---|---|
| 0.135 | 0.40 | 8.22 |
| 0.3 | 0.565 | 10.26 |
| 0.7 | 0.965 | 11.0 |

Curve $B$ of Figure 3 shows the plot for $i$ from this basis. This completes the work for the relationship between current and time.

For question two, assuming first that the saturation curve has been replaced by two straight lines, the stored energy is, for lower part $i=0$ to 3

$$\int_0^t L\frac{di}{dt}i\cdot dt=\int_0^I Lidi=\frac{LI^2}{2}=\frac{0.075\times3^2}{2}=0.337$$

upper part

$i=3$ to 9

$$\int_{t_1}^{t_2} L\frac{di}{dt}\cdot i\cdot dt=\int_I^i Lidi=\frac{L(i^2-I^2)}{2}=\frac{0.0115\times(9^2-3^2)}{2}=0.415$$

a total of 0.752 watt-second.

These same results may be obtained also

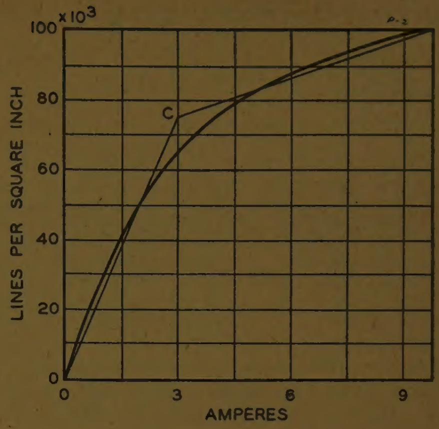


**Figure 2**

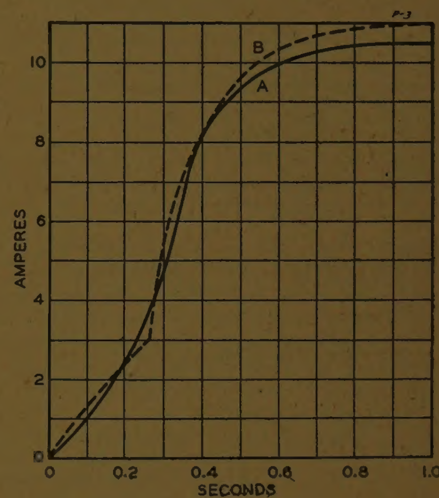


**Figure 3**

from the integrals of $eidt=\frac{N}{10^8}\frac{d\phi}{dt}\cdot i\cdot dt$, taken between the same pair of limits, when substituting

$$\frac{d\phi}{dt}=\frac{75{,}000}{3}\frac{di}{dt}\text{ and }\frac{25{,}000}{9.5-3}\frac{di}{dt}$$

respectively.

This total is lower than that obtained from the standard expression for constant $\mu$, $\frac{B^2}{8\pi\mu}$ (*cgs*). At $i=9$, $\mu=345$, and stored energy$=1.35$ watt-seconds. At $i=3$, $\mu=784$, and stored energy$=0.338$ watt-second.

For comparison when using the power series, for $i=9$ amperes, the stored energy is

$$\int_0^t eidt=\int_0^t\frac{N}{10^8}\cdot\frac{d\phi}{dt}\cdot i\cdot dt=\int_0^i\frac{300}{10^8}\times(33{,}100-85{,}60i+612i^2)\cdot i\cdot di$$

$$=0.0496i^2-0.00856i^3+0.000459i^4$$

$$=4.02-6.24+3.01=0.790\text{ watt-second}$$

and the inductance, $L=\frac{2\times0.790}{9^2}=0.0195$ henry.

It thus appears that cases exist for which the power series is a competitive tool and that its application merits further investigation. Several recent books indicate that such work is in progress.


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## NEW BOOKS • • •

**The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.**

**Heating, Ventilating, Air Conditioning Guide 1944.** American Society of Heating and Ventilating Engineers, 51 Madison Avenue, New York, N. Y. 1,168 pages; roll of membership 104 pages, illustrated, 9 by 6 inches, fabrikoid, $5. (ESL.)

The new edition of this reference book follows the pattern of previous ones. However, it has been revised thoroughly and many new data added to bring it up to date. A new chapter on marine heating and ventilation has been added. The new edition maintains its position as a practical guide to the best practice in its field.

**Aircraft Analytic Geometry.** By J. J. Apalategui and L. J. Adams. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1944. 285 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, linen, $3. (ESL.)

The methods of plane and solid analytic geometry are applied to the solution of a certain class of problems that arise in the design, lofting, tooling, and engineering of airplanes. There is also a treatment of conic sections as used in design and lofting. The approach is systematic and is based on the principles of plane and solid analytic geometry.

**Basic Mathematics for Engineers.** By P. G. Andres, H. J. Miser, and H. Reingold. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1944. 726 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $4. (ESL.)

This book presents in one volume "the mathematics required for an intelligent pursuit of elementary engineering courses and serves as preparation for a course in the calculus." It contains those topics from algebra, trigonometry, and analytic geometry needed to meet these objectives. The text is suitable for home study by students who have had two years of high school mathematics.

**Calculus Refresher for Technical Men.** By A. A. Klaf. McGraw-Hill Book Company, Inc., Whittlesey House division, New York, N. Y., 1944. 431 pages, illustrated, $8^1/_2$ by 5 inches, cloth, $3. (ESL.)

The basic concepts and methods of differential and integral calculus are presented in question and answer form in this book, which is intended especially for men who have studied the subject and wish to review it rapidly. Typical examples are worked out and problems are provided for the student. A section is devoted to practical applications of calculus to engineering.

**Control of Electric Motors.** By P. B. Harwood. Second edition. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, London, England, 1944. 479 pages, illustrated, $8^3/_4$ by $5^1/_2$ inches, cloth, $5. (ESL.)

In this book the characteristics of various types of motors are described briefly and the way in which these characteristics are used to control them are explained. The design, construction, and operating characteristics of a number of controllers and control devices are discussed and methods of combining these devices to secure a desired effect are described. New material has been added in this edition on variable-voltage control and synchronous motor control, electronic control, and so forth.

**Electrical Technology and the Public Interest.** By F. J. Kottke. American Council on Public Affairs, Washington, D. C., 1944. 199 pages, tables, 9 by 6 inches, paper, $2.50; cloth, $3. (ESL.)

This study of our national policy toward the development and application of inventions discusses the extent to which leading concerns can or do control the electrical industry through ownership of patents on the most effective technological methods. The effects of the patent privilege, the part played by company research laboratories, and the matter of patent licensing are discussed at some length. The recommendations of the Temporary National Economic Committee are discussed.

**Foundations of Potential Theory.** By O. D. Kellogg. Published by the Murray Printing Company; distributed by Frederick Ungar Publishing Company, New York, N. Y., 1944 reprint, 384 pages, illustrated, $9^1/_2$ by 6 inches, linen, $6. (ESL.)

This is a reprint of the treatise by the late Professor Kellogg which was published in Berlin in 1929 and which was based on his courses at Harvard University. The first quarter of the book treats the subject in a fairly elementary manner, with applications to gravitational theory, electrostatics, magnetostatics, and the flow of heat but the remainder is more mathematical. The restrictions on the validity of the equations of Gauss and Stokes are examined, and the Dirichlet problem investigated.

**Internal Combustion Engines.** By B. H. Jennings and E. F. Obert. International Textbook Company, Scranton, Pa., 1944. 471 pages, illustrated, 9 by 6 inches, cloth, $4.50. (ESL.)

This text is designed to give students and engineers fundamental and factual knowledge of the broad field of internal combustion engines. Basic analyses are developed in detail for the many processes in the engine and illustrative applications are drawn from current technical literature and manufacturing practice.

**Introduction to Electric Power Systems.** By J. G. Tarboux. International Textbook Company, Scranton, Pa., 1944. 385 pages, illustrated, $8^1/_2$ by $5^1/_4$ inches, fabrikoid, $4.50. (ESL.)

Two general fields are covered in this textbook, the theory and operation of power-transmission systems under balanced steady-state conditions and system characteristics under unbalanced or faulty operation. The introductory material on inductance and capacity is brief, as the student is assumed to be well grounded in these fundamentals. The object of the book is to prepare the student particularly for work in the operating departments.

**Magnesium.** By E. V. Pannell. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1944. 137 pages, illustrated, 9 by $5^1/_2$ inches, cloth, $4. (ESL.)

In this practical treatise on magnesium from the engineering and industrial point of view, the methods of producing the metal are described briefly. Most of the book is devoted to the alloys, their heat treatment, casting and working, corrosion and protective methods, and their industrial application. The book is a useful addition to the literature on magnesium.

**Military Maps and Air Photographs.** By A. K. Lobeck and W. J. Tellington, with an introduction by J. K. Wright. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1944. 256 pages, illustrated, $11^1/_2$ by $8^1/_2$ inches, cloth, $3.50. (ESL.)

The authors, a geologist, and an army topographer, have aimed to supply a complete, yet simple, presentation of the fundamentals of map reading and map interpretation, including air photographs. Techniques and methods are described in detail. Especial attention is paid to the representation of topographic forms by contours though a section is devoted to landscape types. Engineering students, as well as military men, will find the book useful.

**Mr. Tompkins Explores the Atom.** By G. Gamow. The Macmillan Company, New York, N. Y.; the University Press, Cambridge, England, 1944. 97 pages, illustrated, $8^1/_2$ by $6^1/_2$ inches, cloth, $2. (ESL.)

In this admirable bit of scientific humor, Professor Gamow pursues the further adventures of the hero of "Mr. Tompkins in Wonderland." His attendance at a series of lectures on nuclear physics results in three strange dreams for Mr. Tompkins in which he learns of Maxwell's Demon, adventures among the electrons with disastrous results, and probes the mysteries of the nucleus.

**Questions and Answers for Marine Engineers.** Compiled by H. C. Dinger. *Marine Engineering and Shipping Review*, New York, N. Y., 1944. 330 pages, illustrated, $8^1/_4$ by 5 inches, paper, $2. (ESL.)

This book gives practical answers to problems that confront marine engineers. The operation and maintenance of pumps, condensers, and other auxiliary machinery; the application of steam and heat in producing power, and powering; propulsion; propellers; and shafting are the subjects covered.

## PAMPHLETS • • • •

**Guide to Postwar Financial Planning for Manufacturers.** National Association of Manufacturers, 14 West 49th Street, New York 20, N. Y., 18 pages.

**Air Express Now and Tomorrow.** By L. O. Head. Railway Express Agency, 11 pages.